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THE TASHKENT EARTHQUAKE (SELECTED CHAPTERS). PART I.(U)
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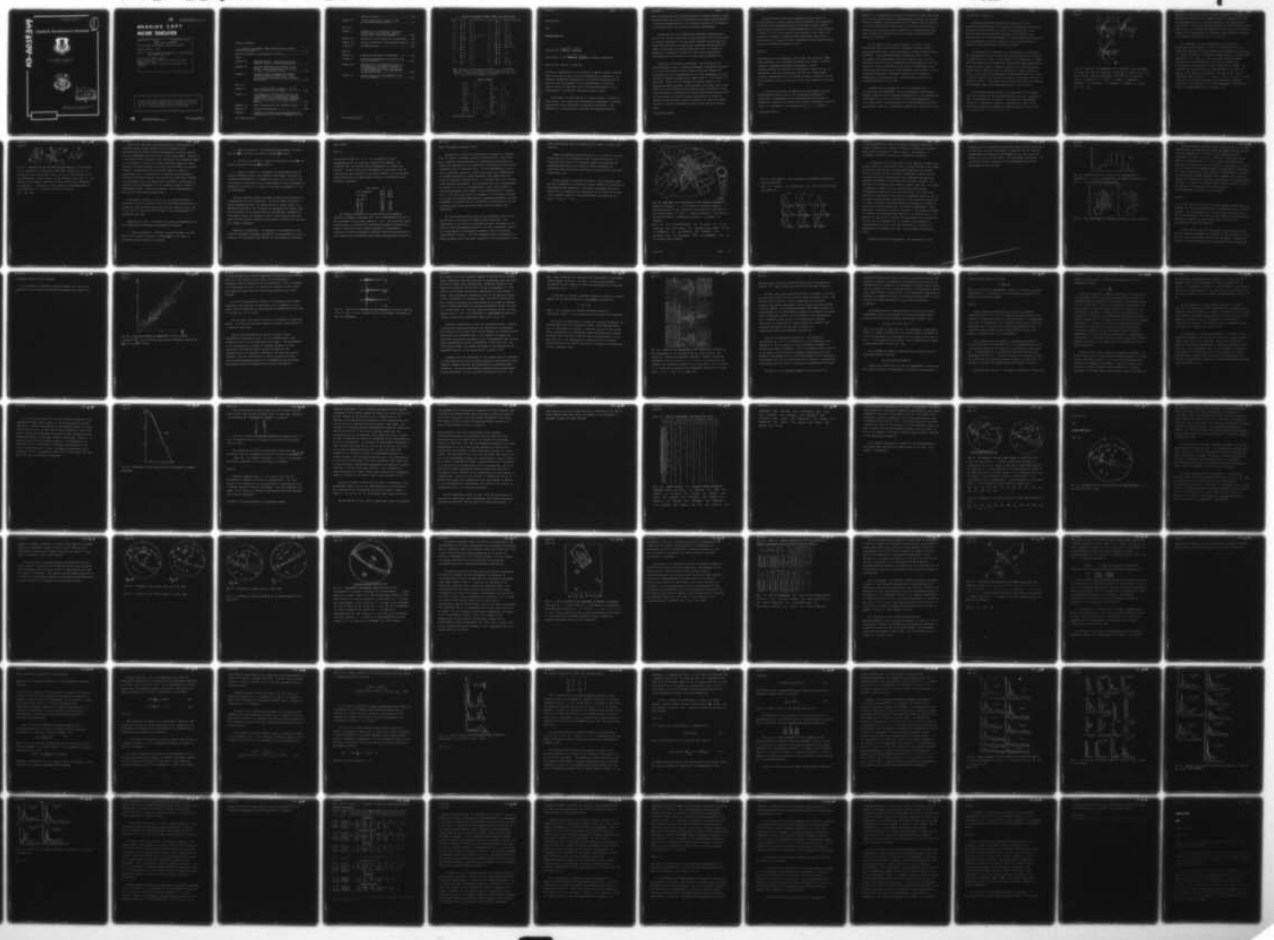

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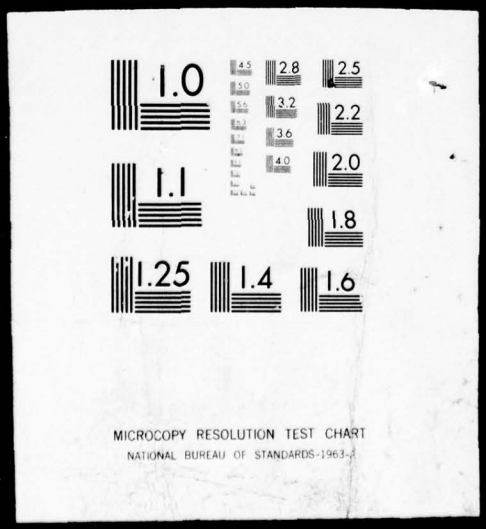

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PART 1 OF 2

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FOREIGN TECHNOLOGY DIVISION

THE TASHKENT EARTHQUAKE
(SELECTED CHAPTERS)

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THE TASHKENT EARTHQUAKE (SELECTED CHAPTERS)

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U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere. When written as ё in Russian, transliterate as yë or ë. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	A	α	*α*	Nu	N	ν	
Beta	B	β		Xi	Ξ	ξ	
Gamma	Γ	γ		Omicron	O	o	
Delta	Δ	δ		Pi	Π	π	
Epsilon	E	ε	*ϵ*	Rho	P	ρ	*ϱ*
Zeta	Z	ζ		Sigma	Σ	σ	*ς*
Eta	H	η		Tau	T	τ	
Theta	Θ	θ	*ϑ*	Upsilon	T	υ	
Iota	I	ι		Phi	Φ	φ	*ϕ*
Kappa	K	*κ*	κ *ϰ*	Chi	X	χ	
Lambda	Λ	λ		Psi	Ψ	ψ	
Mu	M	μ		Omega	Ω	ω	

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Chapter III. ~~Iterative impulses.~~ Repeated shocks

FOCUS REGION OF THE ~~ITERATIVE IMPULSES~~ Repeated shocks OF TASHKENT EARTHQUAKE.

Pages 80-469; 600-672; 3 unnr pgs.

The work of seismologists in the period of numercus iterative impulses under conditicns of large city very stressed and is laborious. Is necessary operational observation of the seismic mode/conditions of fccus zone and the migratien cf the origin/hearths of iterative impulses, which is important for the develcpment/detection of the strike/course of potentially dangerous tectonic region.

Furthermore, the effectiveness of seismic service is caused by mcral factor. The krcwn to all seismolcgists phenomenon of iterative impulses with great difficulty is mastered by pcpulation. And completely it is natural that along with the continuous damping

radio-television scientific popularizatien cf seymologicheskikh values important value they have the instantaneous and clear answer/responses cf attendant seysmostantsii tc the telephone questions of inhabitants ccncerning recently the cccurred undergrcund jerk/impulse.

Operational data are necessary for government organ/controls. The fact is that the small depth of the cccurrence of the gipotsentrov of iterative impulses at the determined intensity of earthquake can create the local zones of destruction, cause the origin/hearths of fires, the precipice of electric power lines etc. As showed the practice, the immediate estimation of the force cf underground jerk/impulse and its deposit in this case plays significant role.

Conditions of recording aftershocks. The lccation of the pleystoseystovoy region of Tashkent earthquake in immediate proximity (1-1.5 km) from central seismic statien "Tashkent" afforded the possibility from the torque/moment of the basic earthquake to record iterative impulses, beginning with energy level K = lg of Yedzh = 4-5 and abcve. Because cf the equipment of seismic station by the seysmometricheskoy equipment, which overlaps wide dynamic range (100 dtsb) and by the possessing high scanning speed cf notation in time (120-240 mm/min), is obtained full-valued seysmctraficheskiy material. The inestimable role during recording aftershocks it played the equipment (N001 and N002), making it possible tc obtain the visible nctatien of oscillation/vibrations with thermal and electrographic paper.

During the first month after earthquake in city, acted two seismic stations - central seismic station "Tashkent" and immediately the leaving into pleystoseystovuyu zone attendant movable seismic station (PSS), installed on chassis/landing gear of the motor vehicle of GAZ-51. At the end of May and the beginning of June 1966 in the territory of Tashkent, produced itself simultaneous recording the aftershocks of 10 seismic stations, distributed around pleystoseystvoy region at epicentral distances 1-15 km.

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Subsequently due to uselessness, their number was shortened to 4-x, which remained to act constantly and entered the system of Tashkent composite seysmogeofizicheskogo range/polygon. During treatment/working the notations of sufficiently powerful ($K \geq 10$) aftershocks, were drawn seismograms more than ten uzbek seismic stations, arrange/located in by crucible framing at distances 50-300 km of Tashkent, and also stations of other union republics of Central Asia.

In spite of sufficient denseness of the grid/network of urban seysmichesikh stations, due to the considerable background of microseismic interferences by the representative energy class of aftershocks, beginning with which the location of stations it does not affect the distribution of epicenters, it is K = 6. Iterative

impulses K = 6 sufficiently distinctly recorded by the most moved away (~10 km) from epicentral zone seysmostantsiyey No 13 and even seismic station of "Sukok", arrange/located 50 km of Tashkent on the rocks of the spurs of Chatkal'skogo spine/ridge. The seismic station No 13 is located in more favorable ground conditions in comparison with other urban stations, and seysmostantsiya the "Sukok" is highly sensitive (increase 20 thousand).

The aftershocks of the energy classes K = 4 and K = 5 were recorded with very small epicentral distances (0-3 km) and were separate/liberated only on the seismograms of central seismic station "Tashkent", having less microseismic background. Even the not seismograms of seysmostantsiy, which are located in the center of pleystoseystovoy region, to reveal/detect such aftershocks it was not impossible. This is explained, on one hand, by unfavorable ground conditions (great thickness of loess deposits), with another - by the considerably vozrasshim immediately after the basic earthquake background of interferences due to intense reducing works in the injured/damaged part of the city.

Procedure for the opredeleiya of the coordinates of the origin/hearths of aftershocks. In all seismological investigations paramount problem is the coordinate determination of the epicenters of earthquakes (x, y) and of the depth of their origin/hearths (h). Since these values - initial during all further constructions and the calculations, from their authenticity depends the reliability of those

cr different conclusions.

Elektrono-computational machine was drawn only for the operational determination of the position of epicenters, and all the constructions were conducted by hand on large-scale plane table. Such, it would seem out-of-date approach, in our opinion, was necessary for the "prochuvstvovaniya" of special feature/peculiarities in the propagation of seismic waves, the more careful analysis of geometric constructions and estimation of error.

For determining the coordinates of aftershocks, are calculated the hodographs of the longitudinal and transverse waves for the range of depths from 1 to 10 km. As the basis of the calculation, is placed the high-speed/velocity cut/section, obtained from seismological data during recording powerful industrial explosions in Pritashkentskom region (Ulomov, 1966) and based on materials of seismic survey and boring. The velocity of propagation of longitudinal waves in the coat of average power 2.4 km is equal to 3 km/s, in that which lay under is equal to 6.0 km/s. The relation of the velocities of the longitudinal and transverse waves are respectively equal to 2.0 and 1.73.

the horizontal-laminar model of the upper part of the earth's crust was accepted not for an entire territory of city. According to data of deep boring in the region of the location of the seismic station No 13 (northeast outskirts of Tashkent) the depth of the occurrence of paleozoic basement is accepted equal not 2.4 km as in the remaining part of the city, but 1 km.

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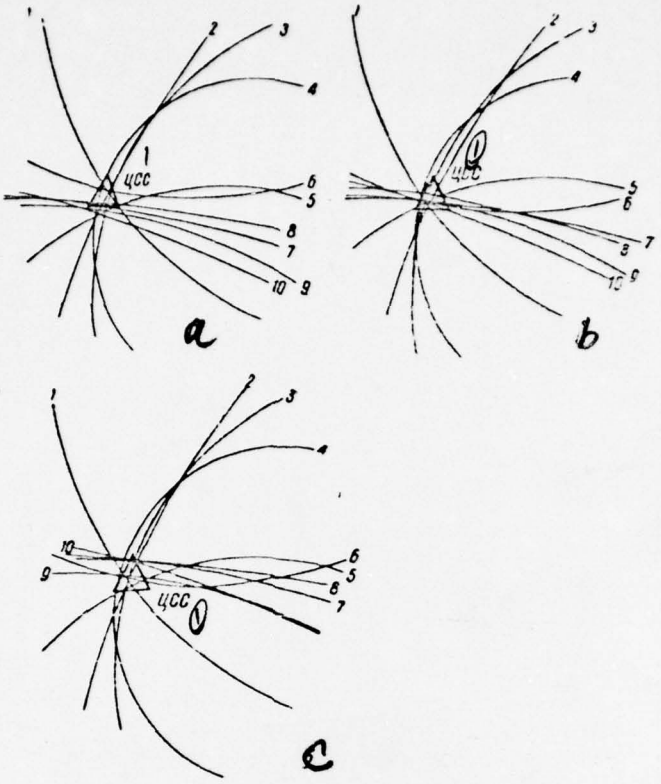

Fig. 35. Coordinate determination of the epicenter of the earthquake on 24 May 1966 from the hodographs, calculated for depths 0 (a), 5 (b) and 10 (c) km. Numerals designated the notches of the stations: 1 - Eskem; 2 - Fergana; 3 - to Chetsu; 4 - Sukok; 5 - Taboshar; 6 - Chimkent; 7 - to Dushaibe; 8 - to Karasu; 9 - Balgaly; 10 - Regar. Key: (1). QSS.

Difference in the deep structure of the northeastern neighborhood of Tashkent was felt and in the anomalous recoil of notches when using for seysmostantsii No 13 standard townspeople high-speed/velocity cut/sections. The special feature/peculiarity of deep structure under this station was considered by subtraction from absolute time of the arrival of the longitudinal and transverse waves and their difference respectively in corrections 0.2, 0.4 and 0.2 s.

The coordinates of the origin/hearths of four powerful aftershocks, which occurred 8, 10 and on 24 May 1966, due to an insufficient quantity of urban stations were determined by the method of notches from data of the regional seismic stations of Central Asia (Arkhangel, etc., 1954). In this case, were utilized regional hodographs with differentiation in the depths through 5 km. Constructions were conducted to scale 1:500,000 and 1:100,000 . As epicenter was accepted the point, corresponding to the center of gravity of the figure of discrepancy. The epicenters of these aftershocks (with respect to K = 10-11, K = 12, K = 11 and K = 10-11) turned out to be those which were arrange/located in immediate proximity of the epicenter of the basic earthquake. The spread of notches corresponded $\pm$ 0.5-1.0 to km (Fig. 35).

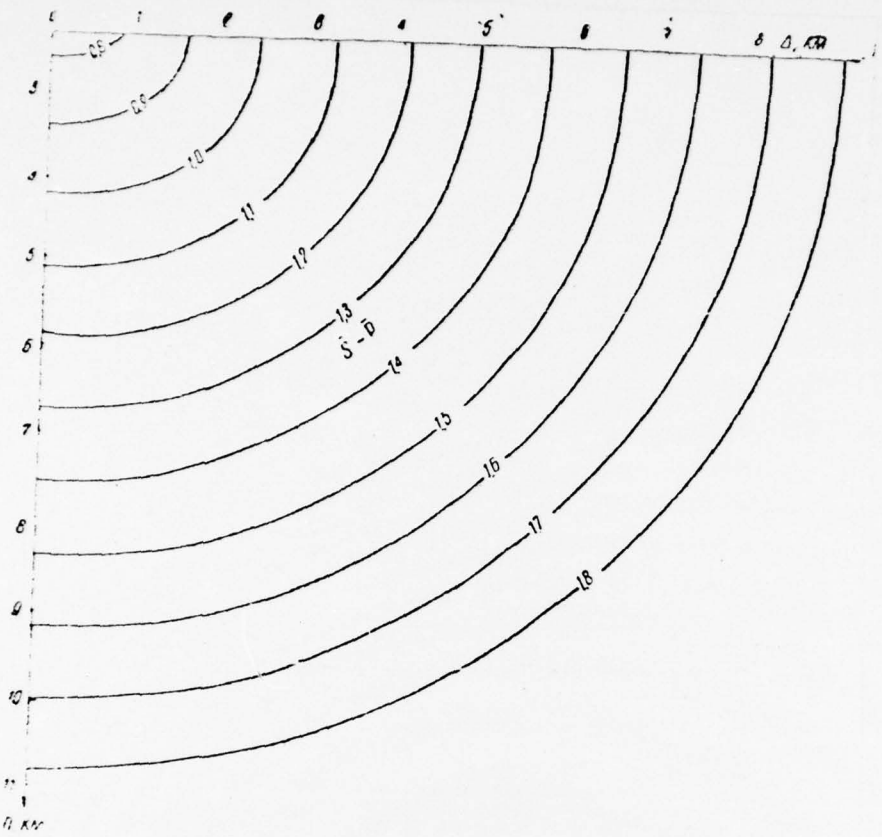

Fig. 36. Nomogram of the dependence of a time difference of the arrivals of transverse and longitudinal waves ($T_S - T_P$ s.) from epicentral distance (Δ, km) and the depth of the gipotsentra of earthquake (h, km).

Jcgging of the epicenters cf repeated tolchikov and depth of the cccurrence of their crigin/hearths was realized cn the seismograms of two urban stations and entailed the fcllcwing. By the plan/layout for city, was transferred the figure of discrepancy and on the difference Tashkent hodograph $\overline{S-P}$ direct/straight transverse and longitudinal seismic waves for twc values of depths they were made two pairs of nctches. Hodographs with differentiaticn in the depth through 1 km were selected in such a way that both pairs cf nctches would not exceed the limits of the figure of discrepancy. Then was located the point cf intersection of the cut, ccnnecting the intersections of two pairs cf notches from direct/straight, imitating the azimuth of arrival longitudinal wave tc QSS "Tashkent". This point was accepted as true epicenter, i.e., as the place where began the vsparyvaniye of rccks. Then cn the ncmcgram of the dependence cf difference S-P on the measured epicentral distance (x, km) and the depth of crigin/hearth (h, km, Fig. 36) it was mcre precisely formulated the depth cf gipotsentra.

As can be seen from ncmcgram, the miscalculation of the depth of seismic center during epicentral distances 2-3 km and errors in the determinaticn of epicenter $\pm$0.5-1.0 km depending on the depth of gipotsentra (3-10 km) alsc varies and the limits $\pm$0.5-1.0 km.

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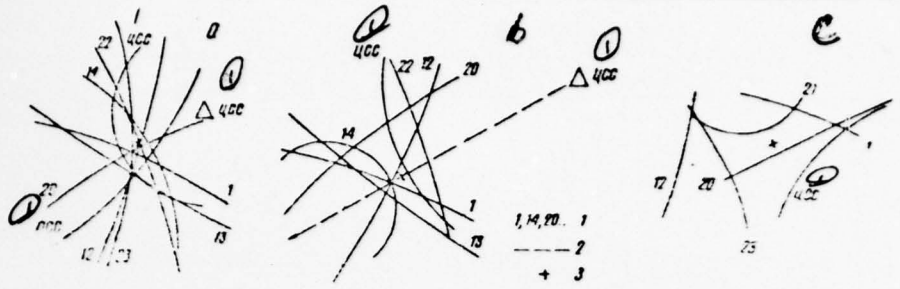


Fig. 37. Determination by the method of the notches of the location of the epicenters of aftershocks 10/VII-1966 3 balls, the kl. of accuracy "a" (a); 29/VI-1966 7 balls, the kl. of the accuracy of "b" (b) 6/VIII-1966, 3 balls, the kl. of the accuracy of "c" (c): 1 - the number of the stations, according to data of which were constructed the notches; 2. the azimuth of the arrival of longitudinal wave to QSS "Tashkent"; 3 - the taken position of epicenter.

Key: (1). QSS.

From 25 May 1966 after discovery/opening in the territory of Tashkent several seismic stations of the coordinate of the origin/hearths all without exception/elimination iterative impulses they were determined only from data of urban grid/network. Because of a good definition of arrivals of the longitudinal and transverse waves in the majority of cases, was utilized difference hodograph, which virtually eliminated errors in the course was chronometer at seismic stations. Considerably later (in middle 1968) as a result of organization by V. I. Ulomov and V. G. Katrenko tsentraliovannoy recording the seismic signals, transferred from three urban stations on subterranean cable to registriry QSS "Tashkent", the accuracy of reading of the torque/moments of the arrivals of waves is bygone is considerably raised. Large role played in this discovery/opening during May of 1966 urban seysmostantsiy.

From data of stations 1, 12, 13, 20, 22, arrange/located at distances 5-10 km of epicentral zone, was determined the position of epicenters, while from the more close (0-3 km) stations of PSS, QSS, 14, 21, and 23 - was corrected the depth of the origin/hearths of aftershocks (Fig. 37).

Estimation of error. The errors in coordinate determination of the epicenters of earthquakes are estimated as follows.

1. Class of accuracy a - stations surround epicenter not less than from 4-x sides, the spread of notches ±200 m and less, is determined azimuth from QSS to epicenter.

2. Class of accuracy b - stations surrcund epicenter not less than with 3-x of sides, the spread of notches ±200-500 m.

3. The class of accuracy c - notch is not less than with 3-x of sides the spread of notches ±500-1000 m.

4. Class of accuracy d - epicenters are determined by data of several staticns, by one or two stations and azimuth. The error in coordinate determination of epicenter is equal tc $_n$1-2 to km, in the determinatien of the depth cf the origin/hearths of the aftershocks of classes of accuracy a, b, c - ±0.5-1.0 km, class of accuracy d - 1-2 km (neklassnye).

With the accuracy pointed cut above are found the coordinates of origin/hearths for 1076 aftershocks. Alcng the method of notches during treatment/working, was applied methcd Tc Vadati (1927), not requiring knowledge of the velocities of propagation of seismic waves. The coordinates of the origin/hearths of aftershccks, determined by this methcd, within the margins cf error in the determinations will agree with the results, cbtained by the methcd cf notches with the use of a Tashkent hodograph.

Map/chart of epicenters. For mapping of the epicenters of the iterative impulses of Tashkent earthquake, the plan/layout for city is broken by the rectangular grid through 25 m (principle of millimeter

graph paper).

For reference point (x = 0, y = 0) is accepted the point, arrange/located on the south-west outskirts of Tashkent. The coordinate axes are directed along geographical to meridian and latitude. Because of the local propagation of epicenters, all the constructions were conducted in the first quadrant. In the selected system the position of urban seismic stations is determined by the following coordinates.

The station	x	y
QSS "Tashkent"	43.0	28.0
the PSS-1	35.2	25.0
	31.7	34.2
the PSS-2		
No 1	29,6	3,4
No 12	11,8	36,2
No 13	62,2	59,0
No 14	35,5	23,8
No 20	48,23	11,7
No 21	36,2	34,3
No 22	14,2	17,2
No 23	28,7	27,8

The compound map/chart of the epicenters of the iterative impulses of Tashkent earthquake (Fig. 38) is constructed according to the aftershocks of the energy classes K = 6-12. The epicentral region of aftershocks is localized and sufficiently clearly is restricted to figure in the form of the ellipse, elongated in southeasterly direction in full/total/complete conformity with the strike/course of the obtained from seismological data plane of discontinuity during the

basic jerk/impulse (azimuth ~135°).

Transverse is 5 km and it stretches from northwest to southeast from the street of Rahimov's Sabira to Pushkin's area. Minor axis 3 km in extent is included between the intersection of the streets of Labzak and Timiryazeva in the northeastern termination of zone and the prospectus navoi in south-west part. On the predolozhenii of minor axis ir south-west direction 1.5 km of the basic zone, independently is separate/liberated the small epicentral zone, which arose as a result of iterative impulses from K = 9-11 24.III 1967, 15.V 1967 and their secondary aftershocks. Low epicentral zone also is approximated by ellipse (1 x 1.5 km in size/dimension), major axis of which is arranged orthogonally with respect to the strike/course of the basic zone. It is interesting that the elongation of the izoseyt, obtained as a result of the makroseysmicheskogo examination/inspection of these earthquakes, coincides with the northeastern strike/course of the low epicentral zone, arrange/located between streets Leningrad and pedagogical.

The interval/gap between large and low epicentral zones in the form of band 1-2 km wide is virtually excess epicenters. This aseysmichnyy in the period of aftershocks section corresponds to the center of the pleystoseystvoy region of the basic earthquake, where at the torque/moment of jerk/impulse, probably, tales are maximally removed elastic strains. The basic epicentral zone of aftershocks is wholly arranged during the right, elevated at the torque/moment of the

tasic jerk/impulse, wing of fracture, and low zone - on left, less deformed.

Almost all powerful aftershocks with K $\geq$ 10 and the base mass weak occurred in the northwestern half of epicentral region. For determining the center of the greatest density of epicenters and development/detection of the degree of their scattering, are constructed the statistical distribution of value $\bar{S}-\bar{P}$ for each urban station (Fig. 39).

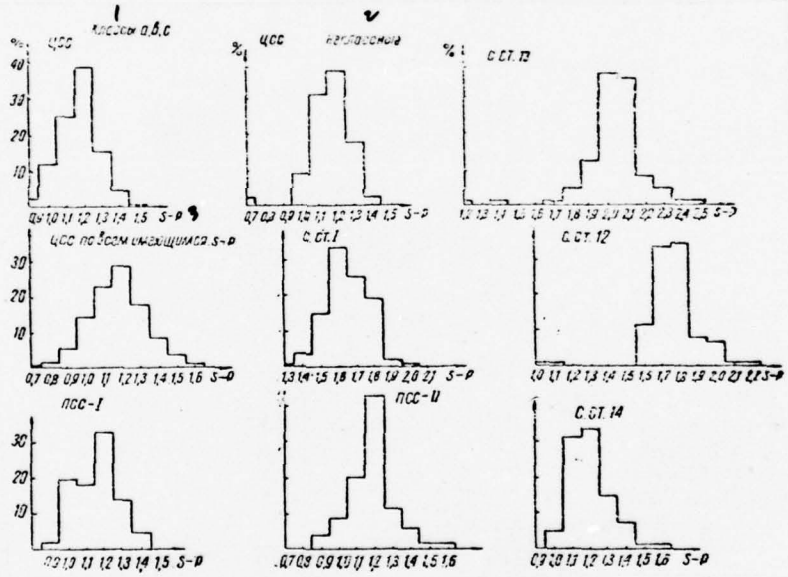
At all stations of inervaly $\bar{S}-\bar{P}$, differ little from each other and their distribution in larger the degrees caused by the position of gipotsentrov, than epicenters. According to maximally widespread values $\bar{S}-\bar{P}$, are calculated the coordinates of the center of the zone of the greatest density of the origin/hearths of aftershocks (x = 38.2, y = 28.5, h = 6 km).

Fig. 38. Map/chart of the epicenters of the iterative impulses of Tashkent earthquake. 1 - the epicenters of iterative impulses (size/dimensions of small circles are conditionally proportional to the energy classes K - lg E); 2 - seismic stations; 3 - the traces of cut/sections along a transversely fracture; 4 - boundary q. of Tashkent.

Key: (1). up. is vysokoval'tnaya. (2). up. mavoi. (3). up. is fraternal. (4). upk. Mirksa. (5). Illegible skoye shasse. (6) up. is pedagogical. (7). up. Chekhova. (8). Chilaksar. (9). Illegible. (10). up. Proletarsk. (11). up. Kuabysheva. (12). up. the Begdena Khmel'nctskogc.

Fig. 39. Distribution of the frequency of aftershocks according to time intervals $\overline{S}-\overline{P}$.

Key: (1). Classes. (2). Neklassnya. (3). ÇSS on all those which are having S-P.



In the plan/layout for city, this place is arranged between the central sections of the streets of Engels and Nasyrova and is moved away from QSS "Tashkent" to west on 1200 m. The denseness of epicenters noticeably decreases in southeasterly direction.

In connection with the fact that a large quantity of aftershocks occurred during the first month after the basic earthquake when worked in city only two stations, and many weak aftershocks are clearly written generally only by one station "Tashkent", closely spaced to epicenter and working continuously, was constructed the analogous dependence $\overline{S}-\overline{P}$ taking into account these iterative impulses. The character of distribution $\overline{S}-\overline{P}$ remained previous (Fig. 39). This makes it possible to assume that the origin/hearths also of these aftershocks are arranged in the same local zone. The latter gave possibility, isol'zuya the obtained by us dependence (see Fig. 36) of the depth of origin/hearth from value $\overline{S}-\overline{P}$ and epicentral distance (on the given previously high-speed/velocity cut/section), to calculate the depths of origin/hearths for the indicated aftershocks. These epicenters are related to class of accuracy d. And finally by taking into account the extremely local character of epicentral zone, it is possible to count that it includes the epicenters of the aftershocks, written only QSS "Tashkent" (on the strength of the different circumstances), for which could not determine S-P. Error in the determination of epicenter for them - $\pm$2 km (radius of epicentral zone).

Hypocentral region of aftershocks. The distribution of the

origin/hearths of aftershocks according to depth is shown in Fig. 40. In this case, the first curve/graph is comprised for the iterative impulses whose epicenters are determined with the high tochnot'yu (classes a, b, c), and the second - for neklassnykh aftershocks. As can be seen from the comparison of both dependences, the law of distribution is not disrupted.

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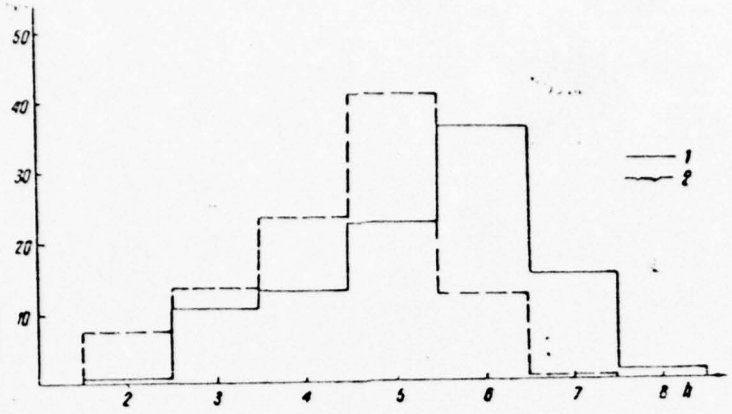

Fig. 40. Distribution of the depths of the origin/hearths of aftershocks. 1 - for the origin/hearths of classes of accuracy a, b, and c; 2 - for meklassnykh origin/hearths.

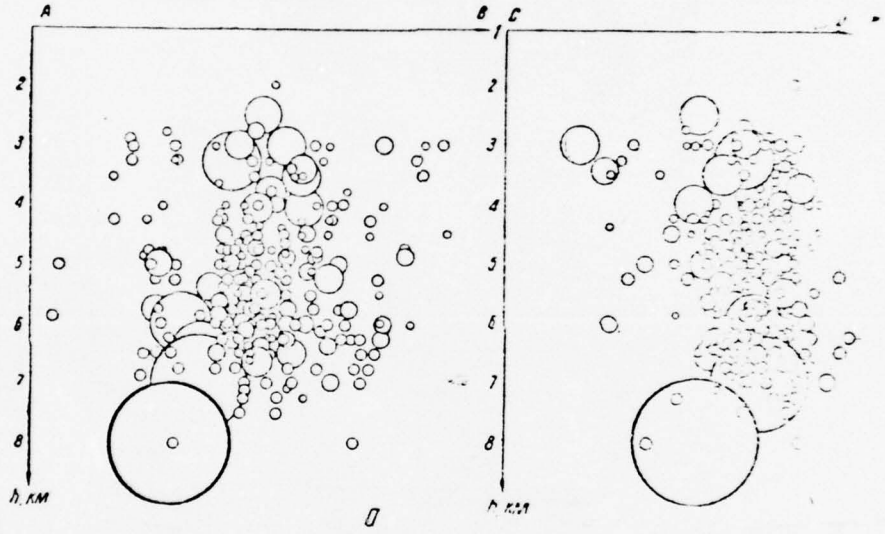

Fig. 41. The cross sections of focus zone on lines AB (a) and CD (b).

The cross sections of focus region on lines AB and by CD, which intersects far and wide epicentral zone and passing through the point with the coordinates of the center of the maximum density of epicenters, are given in Fig. 41. Both in the plan/layout and in depth the origin/hearths of iterative impulses are sufficiently localized and concentrated in the interval of depths from 2-3 to 7-8 km. The center of the maximum density of gipotsentrov is arranged to 1/3 of this interval from lower boundary of focus region. The depth of origin/hearths sharply decreases from northwest to the ngo-east. Gipotsentry sufficiently clearly are approximated by the straight line (in space - by plane), of component with vertical line angle 15-20°. The base mass of origin/hearths is concentrated in krutovozdymayushcheysya band 1.5-2.0 km wide.

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On both sides from the band of the maximum density of gipotsentrov are observed the scattered origin/hearths of comparatively weak iterative impulses. The origin/hearths of the most intense aftershocks ($K \geq 10$) are concentrated in the lower and upper parts of the cut/section, and central, apparently, more crushed part is filled by the gipotsentrami of weak jerk/impulses.

In cross section (Fig. 41b) the gipotsentry of aftershocks are strongly localized, arranged in the limits of vertical band 2 km wide they have only insignificant scattering on periphery. Sufficiently clearly are separate/liberated the origin/hearths of the aftershocks,

which occurred during the left less deformed wing of discontinuity. As it will be shown further, the origin/hearths of the south-west wing of discontinuity differ from those which were arrange/located during opposite wing and from their dynamic parameters.

On both cut/sections as on the map/chart of epicenters, with the quite large small circle shown location it began the basic discontinuity. It is possible that the direction of the south-west boundary of the basic focus zone coincides with the plane of discontinuity at the torque/moment of the main earthquake (slope angle with vertical line ~15°).

Thus, the focus region in which occurred explosive strains, has a form of general ellipsoid with axes $\rangle z = 6$ $\rangle y = 5$ and $\rangle x = 3$ km and is arranged under the center section of Tashkent.

SPECIAL FEATURE/PECULIARITIES OF NOTATIONS AND ENERGY CHARACTERISTICS OF ITERATIVE IMPULSES.

As already mentioned, equipment for central seismic station "Tashkent" provided recording and made it possible to study the dynamic special feature/peculiarities of the notations of iterative impulses over a wide range of their intensity (80-100 dtsb). In this case, the overlap of dynamic range was realized with the aid of several assemblies of registering apparatus.

Since the predominant quantity of aftershocks belongs to relatively low energy classes (K = lg E $\leq$ 9), during the study of the energy characteristics of iterative impulses we used in essence the seismcgraphic material, chtained by commcn type equipment (D. P. Kirnos) with increase in 1000. Partially were drawn the seismograms of seysmometricheskoy equipment with thermal (instrument NOC2) and electrcgraphic (NOO1) nctation. These seismcgrams are convenient in treatment/wcrking because of high scanning speed of process in time (frcm 120 to 240 mm/min).

With the aftershocks of the average and maximum value (K = 10-12) were processed the nctaticns cf the seismcgraphs of mechanical recording SMR-II uv. 7), the acting in urderground pavilion QSS "Tashkent", the seismograms of the stations, arrange/located in the otragakh of Chatkal'skogc spine/ridge 50-70 km cf Tashkent, were utilized data of the bulletins of the mcved away seismic stations of Central Asia.

Special feature/peculiarities of the nctaticns of powerful aftershocks in ekitsentral'ncy region. We avail by all without exceptic/elimination seismcgrams of powerful iterative impulses from K = 10-12, which caused in the regicn of reccrding jolt sootvetsvenno frcm 5-6 to 7 balls.

Fcr convenience in the use, the nctaticns cf the seismcgraphs of mechanical recording were transferred by contact method by

photographic film and then increased.

The seismograms of powerful iterative impulses, as a rule, are complicated by low-frequency oscillation/vibrations with period 5-10 s.

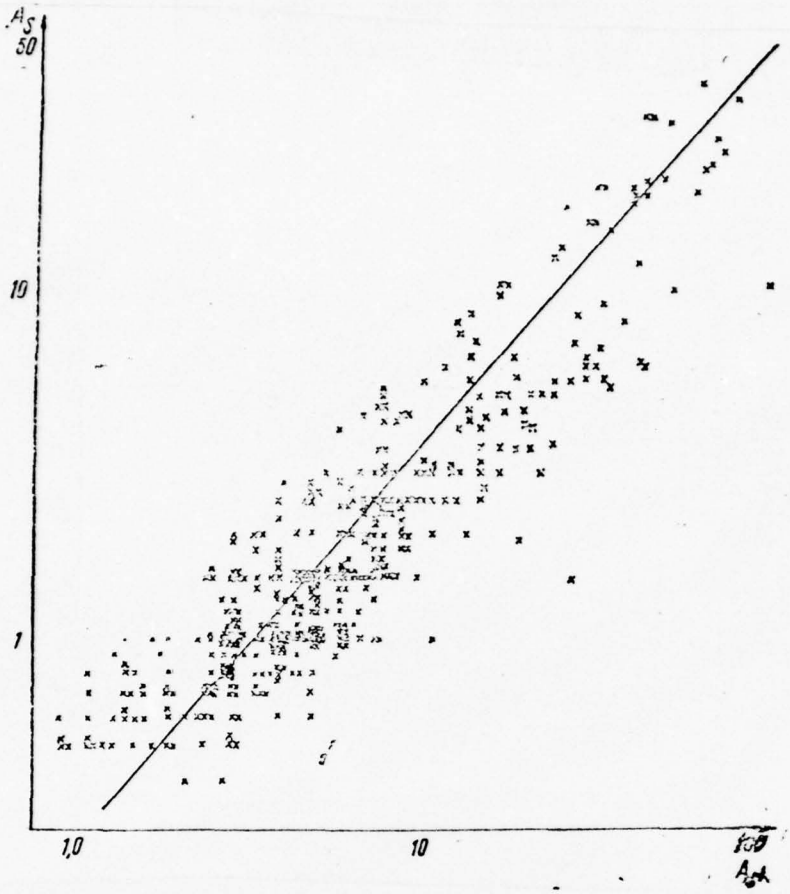

Fig. 42. Dependence between the amplitudes of pulse arrivals ("needles") A'_S and the maximum amplitudes of subsequent oscillations A_S for transverse waves.

The high-frequency most interse component of oscillations has a period 0.3-0.5 s. The periods of less value on the seismograms of instruments SMR-II isolating we did not succeed in. Also any reliably it is impossible to isolate the arrival of transverse seismic waves. They almost are fused with the intense oscillations of the first arrivals.

The basic high-frequency component of oscillations very rapidly attenuates. Its amplitude already after 5-10 s. decreases to 1.5-2 orders while the amplitude of low-frequency oscillations for this time it decreases in all 2-5 times.

With the moved away seismic stations the notations are completely solved. Just they were drawn to evaluate the energy characteristics of powerful aftershocks.

Special feature/peculiarities of the notations of weak aftershocks in epicentral region. As it is bygone agreed, weak repeated push let us call aftershocks with K $\leq$ 9. The seismograms of the zamletryaseniy, recorded in immediate proximity of their epicenters, very sharply differ from the customary to the seismologists of the notations, obtained at the moved away seismic stations. They are characterized by the very intense and clear arrival-momentum/impulse/pulses of the longitudiral and transverse waves whose duration is measured by the visible half-period.

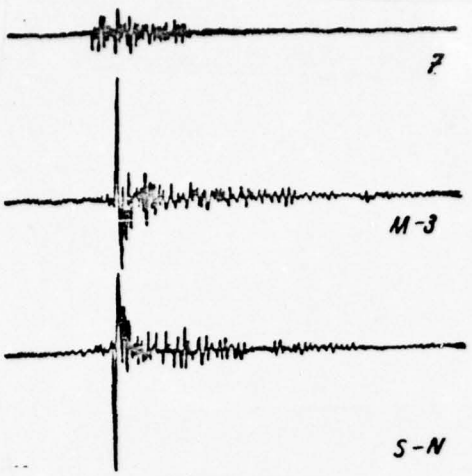

Fig. 43. Copy of the seismogram of the aftershock on 29 April 1966 (K = 7, h = 5 km, I = 2 b), recorded by the electrographic instrument of NOO1 QSS "Tashkent".

As a result, as a rule, notation, appears in the form of two intense bursts ("needles") with the brief loop of considerably less (into 2-4 and even 10 times) dying oscillations. Especially vividly in this respect are expressed the notations of weak jerk/impulses (K = 5-6), where in oscillations participates, apparently, the less volume of rocks. These aftershocks consisted as only of two very short shocks of the longitudinal and transverse waves. But also in the case of more powerful aftershocks the relationship of the values of "needle" and the maximum amplitudes of remaining oscillations (loop) can reach 1-1.5 orders (Fig. 42). Are here used the notations of 403 iterative impulses with K = 5-9. This dependence is approximated by the cut of straight line and dual logarithmic scale $\lg A_s = 1{,}1 \lg A_s' - 0{,}56$.

Analogous relationship is noted for longitudinal waves. However, to accurately reveal/detect/expose this dependence is considerably more difficult due to small time interval between the "needles" of the longitudinal and transverse waves. The character of damping the subsequent longitudinal vibrations can be reveal/detected only at high speed time/temporary razvertk (instruments of NCC1, Fig. 43). The relationship between the maximum amplitudes of the longitudinal and transverse waves as it was communicated, is equal to 0.45.

Analogous with the seismograms of the powerful iterative impulses of the notation of the weak iterative impulses of the notation of weak iterative impulses they are the superposition of raznochastotnykh vibrations. The basic high-frequency component which includes pulse arrivals ("needle"), it has a period of vibrations 0.2-0.3 s. (3-5

Hz). These vibrations are ccmplicated by insignificant in amplitude higher harmonic (8-14 Hz). In turn,, the basic high-frequency cscillaticns in the majority of cases are superimposed on long-period cscillations with T = 2-5 s.

Is planned the definite dependence between the value of iterative impulse and the maximum period cf lcw-frequency cscillations:

$$T = 1{,}2(K - 4{,}4),$$

where - T it is planned the maximum oscillatcry period of cscillaticns, and K = lg E is planned the energy class of aftershocks.

Note by us the phencmenon of single pulse arrivals ("needles") is characteristic only for a epicentral region. With removal/distance from it, wave picture noticeably is ccnverted instead of the intense single (longitudinal and transverse) momentum/impulse/pulses appears the group, which consists cf several momentum/impulse/pulses (3 and mcre, Fig. 44). This seismcgram is characteristic for the urban seismic station No 13, which is located at a distance of approximately 1C km cf epicentral zcne.

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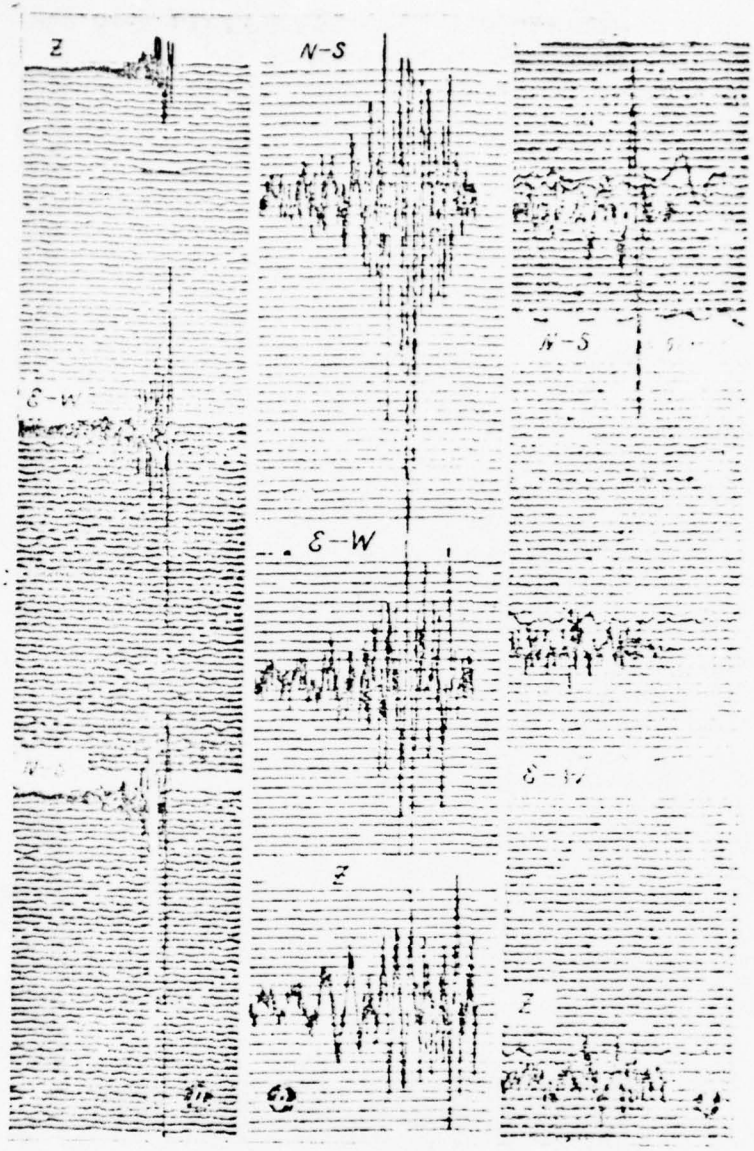

Fig. 44. Copies of the seismograms of the aftershocks, recorded by the seismographs of CSS "Tashkent" and the urban stations: the notation of common type instrument (synthetic rubbers + GK-VII CSS "Tashkent") on 25 May 1966, K = 8, h = 5 km, I = 5-6 balls (a), by regional type instruments (stage 13) on 15 May 1967 K = 9, h = 3-4 km, I = 5-6 balls (b) by regional type instruments (stage 1), on 29 June 1966, K = 9, h = 3 km, I = 5-6 balls (c).

With the seismic station of "Sukok" (50 km) notation completely is smoothed k it accepts usual form without any noticeable ejections.

By their nature pulse arrivals ("needle"), apparently, they have the most direct relation to the shift of rocks in seismic center. The following after them less intense oscillations are connected, possibly, with elastic protsesami in focus region and repeated waves in laminar medium. During removal/distance from seismic center, the impoverishment of the high-frequency component of oscillation spectrum occurs considerably faster than the weakening of its low-frequency part. Because of this, and also in connection with multiple reflections and refractions in laminar medium the "needles" first seemingly multiplied, and then they are fused into common/general/total quasi-harmonic oscillations.

Nature of low-frequency oscillations. The presence of low-frequency (T = 2-10 s.) oscillations on the seismograms of QSS "Tashkent" it is not possible to explain rezktsiyey equipment to intense pulse effects ("needle"). This is confirmed by the difference in the value of the decrement of damping oscillations both at the different jerk/impulses and for all jerk/impulses and the pendulums of seismographs, and also by a difference of the periods of low-frequency oscillations from the period of the natural oscillations of pendulum.

The nature of low-frequency component we connect with the

formation of surface wave under conditions of epicentral region. The attempt to determine the velocity of propagation of this wave by the correlation of its phases on the seismograms of several urban stations was not possible due to the practical absence of low-frequency wave on other urban stations. Assuming that the low-frequency oscillations on notations are composed not only of recording the displacement of soil, but also its slope/inclinations, let us conduct quantitative estimation.

The pendulum motion of seismograph in the case of the seismic oscillations, which are accompanied by slope/inclinations, can be described by the following equation (Savarenskiy, Kirnos, 1955):

$$\theta'' + 2\varepsilon\theta' + n^2\theta + \frac{1}{l}(x'' - \varphi g) = 0,$$

where θ is an angle of deflection, ε - the coefficient of dispersive forces, n - angular frequency, l - the reduced length of pendulum, x" and φ the acceleration of displacement and the angle of the slope of soil, g - the acceleration of gravity. Thus, perdulum motion depends on the combinations of value (x" - φg).

Let us examine the forced pendulum motions, caused only by the slope/inclination of soil φ_m:

$$2\theta'' + 2\varepsilon\theta' + n^2\theta = \frac{g}{l}\varphi_m \sin(pt + \delta).$$

Solving this equation for the case of galvanometric recording, we will obtain the value of displacement on notation y, proportional to

the angle of the slope of soil ϕm:

$$y = \frac{g\varphi m}{n^2} \cdot V \cdot W,$$

where V a normal (for displacement) increase in the system pendulum - galvanometer; W - calculated by us the frequency characteristic of channel for slope/inclinations.

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During recording surface waves by common type equipment (synthetic rubbers + GK = VII) at sufficiently large distance from epicenter, the portion/fraction of slope/inclinations on seismograms, as a rule, is insignificant and it composes unity or the fractions of percentage from the value of the recorded displacement of soil. In epicentral angular region of the slope/inclination of soil with shaping of surface waves can be considerable.

Let us assume that the equipment, established/installed in epicentral region to QSS "Tashkent", to a considerable degree reacts to the surface slopes of the Earth during propagation low-frequency wave. Arrange/locating, for example, by data on the value of the displacement of soil (A = 1 mm) and the period of oscillations ($T \approx 6$ s.), noted with the strongest iterative impulse on 10 May 1966, it is possible to evaluate the maximum angle of the slope of soil ϕm.

Calculated thus value $\phi m = 2.0''$ makes it possible to evaluate the

length of surface wave λ = 200 m, and consequently also of its propagation velocity

$$V = \frac{\lambda}{T} \approx 33 \text{ м/сек.}$$

Thus, it is possible to make an assumption, on one hand, about the considerable role of slope/inclinations during recording by seysmometricheskoy equipment for oscillations in epicentral region, but on the other hand - about the possibility of the existence of surface waves at anomalously small velocity of propagation. The last/latter assumption is confirmed by the being encountered in seismological literature report/communications about the visually observed undulations of the surface of the Earth during the strongest earthquakes. In Tashkent the observers sufficiently distinctly perceived the direction of the motion of seismic oscillations. Low-frequency surface waves can be connected with the elastic deformation of the most plastic upper thickness of glinopodobnykh rock/species. To any degree they are caused by gravitation effect because of relative to the small value of the modulus of shear of these rock/species.

Energy of the iterative impulses of Tashkent earthquake. The seismic energy E is the most important physical parameter of seismic center. The energy classes K = lg E for iterative impulses are determined by nomogram T. G. Rautian. Using this nomogram it is possible to calculate seismic energy according to the maximum amplitudes of the longitudinal and transverse waves not allowing for

the oscillation frequency and their duration. In this case, the probable error in the determination of energy comprises, in the opinion T. G. Rautian, 0.4 orders. At the principle of this nomogram, lie/rests the classification in the flow value of the seismic energy through the sphere of the fixed radius (referenq-sphere), equal to 10 km.

The determination of energy classes by means of the simple addition of the amplitudes of the longitudiral and transverse waves, especially weak aftershocks, in our case is justified by the fact that pulse arrivals ("needle") really/actually they will contain the basic fraction of seismic energy. If "needles" are not noticed by interpreter and energy it is determined from the subsequent maximum amplitudes, the probable error was 0.5-1.0 K.

The possibility of applying a nomogram T. G. Rautian at small hypocentral distances (on the order of 5 km), i.e., within referenq-sphere, have verified we as follows. Using by the definition of energy from the maximum amplitudes, we obtained energy classes both from data of the epicentral station of CSS "Tashkent" and from the seismograms of the moved away (50 km) seismic station of "Sukok". Seysmostantsiya "Sukok", while that which was arrange/located on bedrocks and having high sensitivity, recorded sufficiently well even aftershocks with K = 5-6.

Table 10. Energy classes and magnitudy, acccrding to data of Central-Asiatic (1) and Pritashkentskikh (2) seismic stations.

1 Дата	Время (местное, час. мин.)	1					2						
		n	$K_{ср}$	n	$M_{ср}$	$K_м$	n	$K_{ср}$	n	$M_{ср}$	$K_м$	K	K^1
4.V 1966	03—10	11	11,0	5	3,9	11,0	5	10,9	5	3,9	11,0	11,0	11,3
10.V 1966	00—45	8	12,0	6	4,4	11,9	4	11,8				12,0	11,6
10.V 1966	00—50	6	12,2	4	4,4	10,9	4	11,0	3	3,7	10,7	11,0	10,5
21.V 1966	13—50	8	10,8	6	3,7	10,6	4	10,7	3	3,7	10,7	10,5	10,7
5.VI 1966	03—11	11	11,2	6	4,0	11,2	5	10,7	4	3,8	10,8	10,5	11,1
29.VI 1966	15—00	4	10,7	6	3,7	10,6	4	10,5	2	3,6	10,5	10,5	11,0
4.VII 1966	20—22	8	11,1	7	4,0	11,2	4	10,9				11,0	11,0
13.X 1966	17—10	8	10,0	1	3,1	9,5	5	9,3	4	3,2	9,7	9,5	
24.III 1967	13—04	11	10,6	6	3,7	10,6	5	10,4	4	3,6	10,5	10,5	

Key: (1). Date. (2). Time (local, hour min.).

The correlation dependence between the energy classes, obtained from danym by QSS "Tashkent" and the seysmcstantsin of "Sukck", indicates the relatively gccd agreement cf these values.

Although the deviations are located of the errcrs of the calculations of the value cf energy, energy classes, through data of the statien of "Sukok", systematically lcwer of the half of the crder of magnitude of the classes, determined cn the nctations of QSS "Tashkent". This disagreement we explain by lccal mounting conditions cf equipment and by impoverishment cf the high-frequency part of the cscillatien spectrum, reccrded by the statien cf "Sukok". Thus, ncmcgram T. G. Rautian it is possible tc use, also, during cbservations within refereng-sphere. In this case, the value of classes is determined as before by the flcw cf the seismic energy through the refereng-sphere 10 km in radius.

The energy of powerful iterative impulses (K = 10-12) was calculated from seismograms pritashkentskikh and data of the bulletins cf Central-Asiatic seismic stations. Simultaneously with the determinatien cf the energy classes K by the method pointed out above were calculated magnitudy M of iterative impulses from amplitudes and periods of surface waves (Table 10), here fcr all jerk/impulses shown lccal time, is given a quantity of the seismic stations n, from which simultaneously were calculated the averaçe values of the energy classes K and of magnitud M; formula T. G. Rautian the translatien/ccnversion of magnitudy intc class K = 1.8 M + 4 (Riznicherkc, 1959, etc.) and resultant values cf the energy classes

K.

As can be seen from table, the energy classes, determined by all enumerated methods, within margins of error will agree well between themselves. Exception/elimination is the iterative impulse on 10 May 1966 00 hours 50 min. In this case we gave preference to data of the seismic stations of Pritashkentskogo region as most informed on local mounting conditions of equipment (station corrections). Value K = 11, accepted by us for this iterative impulse, it is confirmed by the estimation of Ye. M. Butovskoy's its energy class according to the flow of seismic energy (K = 10.5). The energy flows seismic wills (calculated by Ye. M. Butovskoy) and for other 6 aftershocks (K^1) will agree well with our resultant estimations.

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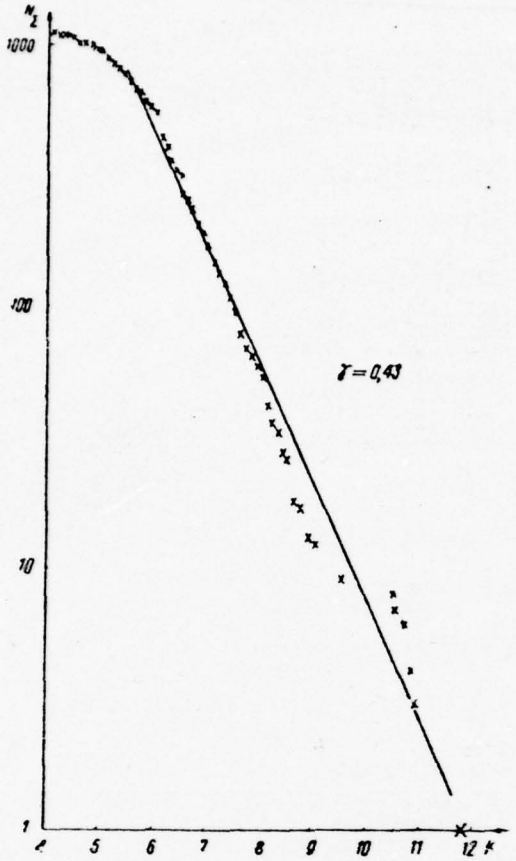

Fig. 45. Curve/graph of the addition of the aftershocks of Tashkent earthquake.

Thus, we determined energy classes for 1076 iterative impulses from 26 April 1966 through 9 December 1968. In this case, quantity N of aftershocks was distributed on classes K as follows:

K	N_Σ
4	1076
5	1031
6	686
7	263
8	67
9	21
10,5	8
11	4
12	1

We did not succeed in accurately isolating aftershocks with K = 10. In connection with this the blyl is introduced the fractional class K = 10.5.

The curve/graph of addition (Riznichenkc, 1964) takes the rectilinear form and apporksimiruyet well all pcints of dependence $N_\Sigma = N_\Sigma(K)$ (Fig. 45). Its angular coefficient, γ = 0.43, it corresponds to the angular coefficient of the curve/graph of frequency.

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Iterative impulses with K $\leq$ 5, as can be seen from the curve/graph of addition, they are not representative. The total energy of the seismic waves of all aftershocks is approximately 4o/o of seismic energy of the basic earthquake. This value completely is placed in the interval of analogous relationships for other powerful and strongest earthquakes.

MECHANISM OF THE ORIGIN/HEARTHS OF ITERATIVE IMPULSES.

Powerful aftershocks. Since 8 powerful aftershocks of the Tashkent earthquake of 10-12 energy classes are written by a large quantity of seismic stations of Central Asia by A. I. Zakharcva and L. M. Matasova, is investigated the mechanism cf their origin/hearths with the aid of A. V. Vvedensoy's methcd (Is Bepcrt, 1956, 1960). The procedure fcr treatment/working instrument/tcol these all aftershocks when using rotations of the seismic stations, mcved away frcm origin/hearth up to the distances, which exceed 40-50 km, is bygone the same as described in chapter II (mechanism cf the origin/hearth of the basic jerk/impulse). Fcr research on fcur pcwerful aftershocks, which cccurred after May 1966 (5. VI; 29. VI; 4. VII; 24. III 1967), we we avail by supplementary material. At the end of May 1966 directly on the territory cf city are established/installed the seismic staticns, which surrcund epicentral zone. The investigation cf the signs of displacement intc the lcngitudinal waves, which came to these stations, substantially supplemented the materials, cbtained frcm data of the more moved away stations. The coordinates of ccnditicnal points fcr urban stations are cbtained on the privedenomu higher cut/section of the earth's crust in the territory of city.

The copy of seismic stations and the signs cf displacement into lcngitudinal waves, used for the determiraticns cf the mechanism of the origin/hearths of aftershocks, are given in Table 11 (under numbers 1, 12, 13, 14, 20, 21, 22 are shcwn urban seismic stations).

The distribution of the signs of displacement during aftershocks,

the orientation of the horizontal projections of nodal surfaces, axes of shifts into origin/hearths and of principal stresses are shown in Fig. 46-53. The copy of the investigated aftershocks, their depth, the classes of energy and the corresponding dynamic parameters of their origin/hearths are given in Table 12.

For earthquake 8. May 1966, strike/course of the possible discontinuity surfaces in origin/hearth and the angles of their incidence/drop can be changed due to the location of conditional points on 5-10°C (Fig. 47). But the necessary condition of the mutual perpendicularity of both discontinuity surfaces in origin/hearth satisfy only the positions of their projections (in Fig. 47 - solid lines). For earthquakes 10.V, 24.V, 5.VI and 4.VII 1966, position of one of the discontinuity surfaces in origin/hearth is rigidly fixed by the location of observation points. Another surface can be displaced by 5-25° both on the strike/course and on incidence/drop. But, as in the case 8.V 1966, its selected position (solid line) strictly it corresponds to the condition of the orthogonality of nodal surfaces in origin/hearth. Therefore it is possible to consider that errors in drawing nodal lines and, consequently, also other dynamic parameters of the origin/hearths of aftershocks, that depend on the location of observation points, are virtually negligible.

For all aftershocks, except 24. Mar. 1967, the distribution of the signs of displacement into longitudinal waves almost completely is repeated and analogous with the same with onovnom jerk/impulse. A

sign change at one and the same stations is noted only in the case of their location near nodal lines, for example, at the stations of Tabоshar, Balgaly and urban stations.

Table 11. Signs of displacement into prodl'nykh waves.

1 Сейсмическая станция	2 Повторные толчки Ташкентского землетрясения (дата, час., мин.)							
	8.V 1966 03,10	10.V 1966 00,45	10.V 1966 00,50	24.V 1966 13,50	5.VI 1966 03,11	29.VI 1966 15,00	4.VII 1966 20,22	24.III 1967 15,04
3 Ташкент	+	+	+	+	+	+	+	
4 Сукок	+	+	+	+	+	+	+	+
5 Чимган	−	−	−		−	−		−
6 Четсу	−	−	−	−	−	−	−	+
7 Табошар	−	−	−	+	+	+	+	−
8 Чимкент					−	−		+?
9 Пскем	−	−	−	−	−	−		+
10 Балгалы	−	+	+	−	+?	−		−
11 Чорку	+		+	+		+		+?
12 Заркент	−	−	−	−	−	−		
13 Наманган	−	−	−	−	−	−	−	−?
14 Фергана	+	+	+	+?				−
15 Кадамжай	+			+	+			−
16 Самарканд		+		+	+			
17 Андижан		+	+				+	
18 Агалык	+	+	+	+	+	+		−
19 Ош	+		+					
20 Джерино		+		+	+	+	+	
21 Калайдашт		+					+	
22 Норсади	+							
23 Чуянгарон	+		+	+	+			
24 Регар	+	+		+?	+			
25 Карасу		+		+	+	+		−
26 Душанбе	+	+	+		+		−	
27 Богизагон		+		+				
28 Больджуан	+	+		+	+	+	+	−
29 Лангар	+	+		+	+	+		
30 Салямалик	−					−		−
31 Куляб						+		
32 Софикурган	+	+	+	+	+			−
33 Фрунзе	+?							
34 Хорог	+	+			+	+	+	
35 Нарын	+?							
36 Мургаб			+					
37 Кировское								−
№ 14				+	−			
№ 21						+	+	
№ 20						+	−	
№ 1					−	−	−	−
№ 22						−	−	
№ 12					−	−	−	−
№ 13						−	−	−

Key: (1). Seismic station. (2). Repeated senses of Tashkent earthquake (date, hour, min.). (3). Tashkent. (4). Sukok. (5). Chimgan. (6). To Chetsu. (7). Taboshar. (8). Chimkent. (9). Pskem. (10). Balgaly. (11). To Chorku. (12). Zarkent. (13). Namangan. (14). Fergana. (15). Kadamzhay. (16). Samarkand. (17). Andizhan. (18). Agalyk. (19). Csh. (20). Dzherino. (21).

Kalaydasht. (22). Chorsadi. (23). Chuyançaron. (24). Regar. (25). To Kararu. (26). Dushanbe. (27). Bogizagon. (28). Bel'dzhuan. (29). Langar. (30). Salyamalik. (31). Kulyab. (32). Sofikurgan. (33). Frunze. (34). Khorog. (35). Naryn. (36). Murgab. (37). Kirov.

To the analogous distribution of the signs of displacement corresponds the similarity of the dynamic parameters of aftershocks to the dynamic parameters of the basic jerk/impulse (Fig. 54). The values of the corresponding dynamic parameters of the origin/hearths of the given earthquakes differ only by 5-10°. Only in two cases this difference increases to 20-30° for the azimuths of the discontinuity surface and axes of shifts over flat discontinuity surface and in one case - to 40° for the azimuth of the axis of tensile stress, which is explained by its abrupt/steep occurrence.

Both possible discontinuity surfaces in the origin/hearths of aftershocks have southeasterly strike/course, one of them - flat, another - abrupt/steep.

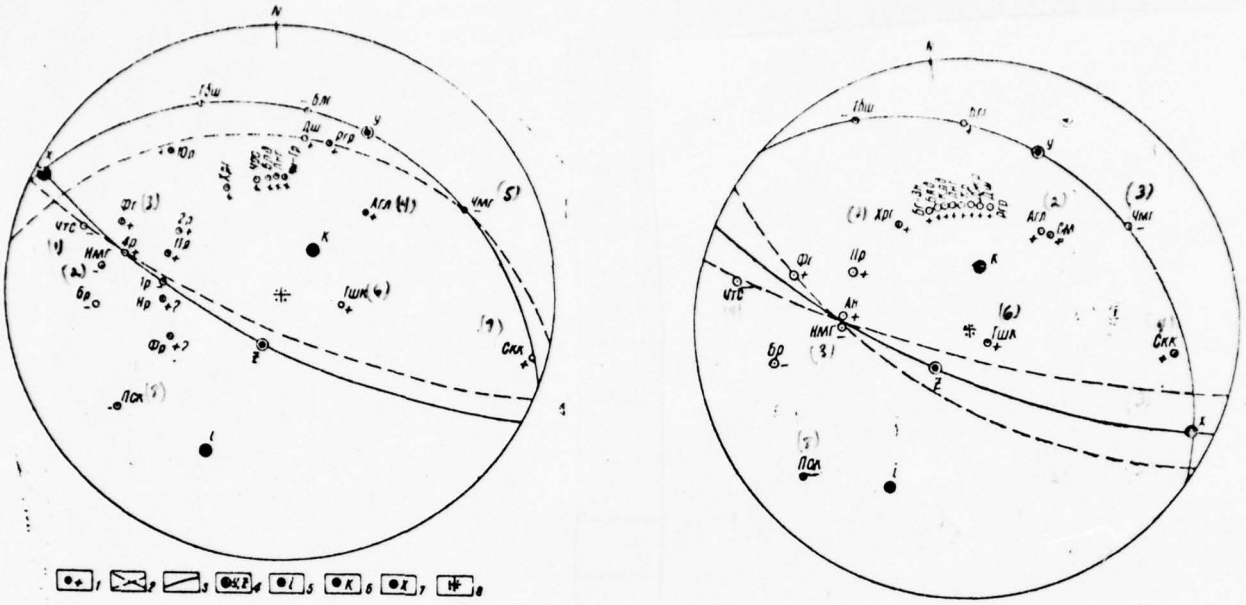

Fig. 46. The mechanism of the seismic center on 8 May 1966 (conv. desig. for Fig. 47-53): 1 - seismic stations and the signs of displacement into wave P (names of stations are abbreviated/reduced; see Table 8); 2 - the end positions of the nodal lines of P-waves; 3 - the selected positions of nodal lines; 4 - the orientation of the axes of shifts; 5 - the orientation of axis of contraction; 6 - the orientation of axis of dilatation; 7 - the orientation of intermediate axle; 8 - the projection of seismic center on Wulf's grid.

Key: (1). CTS. (2). NMG. (3). Fg. (4). AGL. (5). CMG. (6). GWK. (7). SKK. (8). PDR.

Fig. 47. Mechanism of the seismic center on 10 May 1966 (00 hours 45 min).

Key: (1). XRG. (2). AGL. (3). CMG. (4). CTS. (5). NMG. (6). GWK. (7). SKK. (8). PDR.

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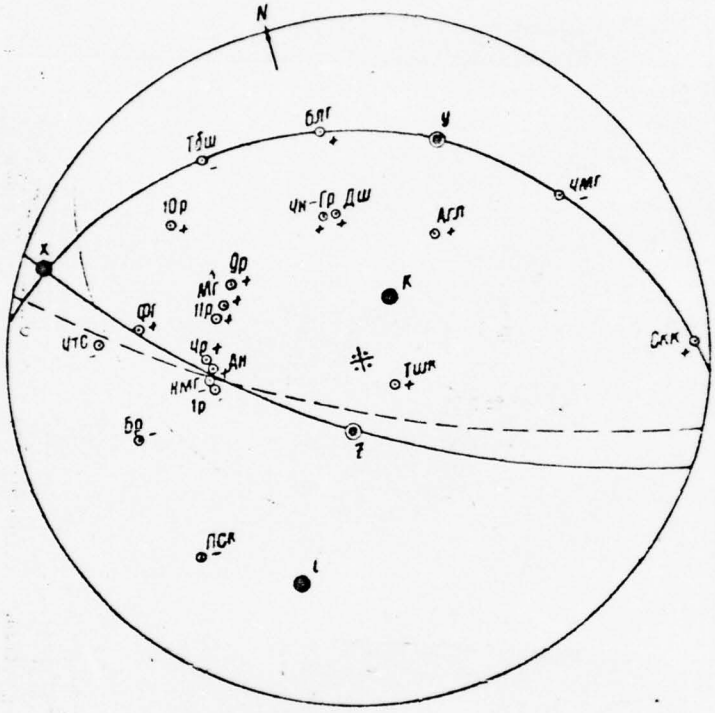

Fig. 48. Mechanism of the origin/hearth of the zemletryaseiya on 10 May 1966 800 hours 50 min).

The character of shifts by these surfaces, reveal/detect/exposeed during the study of the basic jerk/impulse, is retained for aftershocks. Over flat discontinuity surface with all aftershocks 1966, occurred the shifts of the type of overthrust with which the south-west edge of discontinuity was raised and displaced to northeast relative to northeastern edge. Over abrupt/steep discontinuity surface, are noted vzbrosovcgc type shifts by which the northeastern edge of discontinuity is raised and displaced to south west relative to south-west edge.

The orientation of two axes of principal stresses - the axis of contraction and intermediate axle - is changed with aftershocks very little (Table 12). For the investigated aftershocks as and for the basic jerk/impulse of Tashkert earthquake, the axis of contraction flat has a northeastern strike/course, an axis of dilatation - abrupt/steep and stretches in northeastern direction, intermediate axle is almost horizontal and oriented toward scutheast.

The dynamic parameters for the aftershock on 24 March 1967 radically differ from all preceding/previous (see Fig. 53). The signs of displacement can be divided only by one nodal surface of northeastern strike/course. According to the available data it is not possible to confidently define the dynamic parameters for the seismic center on 24 March, as this is bygone made for other iterative impulses, it is possible to only make some assumptions about the possible versions of the mechanism of origin/hearth.

If we proceed from assumption about the most frequently being encountered quadrant distribution of the signs of displacement, then it is possible to assume that two quadrant of signs was not reveal/detect/exposeed due to not the entirely successful location of seismic stations with respect to seismic center or that picture degenerated.

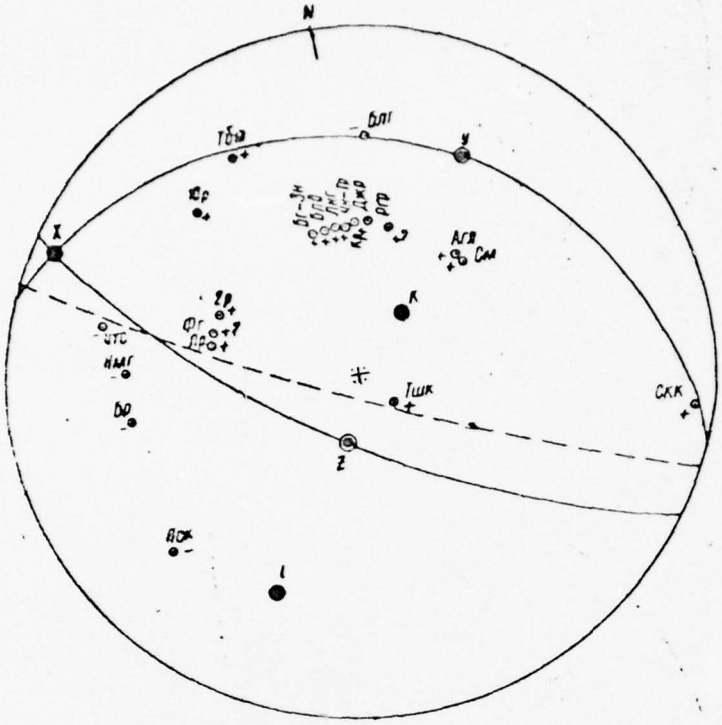

Fig. 49. Mechanism of the seismic center on 24 May 1966. this can occur only in the extreme case of the location of nodal surfaces when one of them is vertical, and another - horizontal.

Then, accepting nodal line as projection of one of the possible discontinuity surfaces in origin/hearth, that slopes almost it is vertical, the second surface can be determined by usual methods, it will be almost horizontal. In this case the dynamic parameters of origin/hearth correspond those which were given in the last/latter row Table 12. The axes of contraction and elongation are oriented in southeasterly direction (Az = 145°) and are inclined at angles of 140-50° toward vertical line; intermediate axle is horizontal. Both possible discontinuity surfaces in origin/hearth are oriented in northeastern direction (Az = 55°), one of them is almost vertical,

another - is almost horizontal. So will lie the axes of the possible shifts in origin/hearth; along the axis, close to vertical (y), dislocation is represented by almost vertical drop, along the axis, close to horizontal (z), by flat sbrovom.

If we proceed from assumption about the existence only of two mixing regions - compression and elongation, and not four as usually with shift/shear, then the given in Fig. 54 nodal surface will seem the surface of breakaway. This surface will lie almost vertically and is oriented in northeastern direction, southeasterly block/module/unit is moved relative to northwestern in nge-eastern direction.

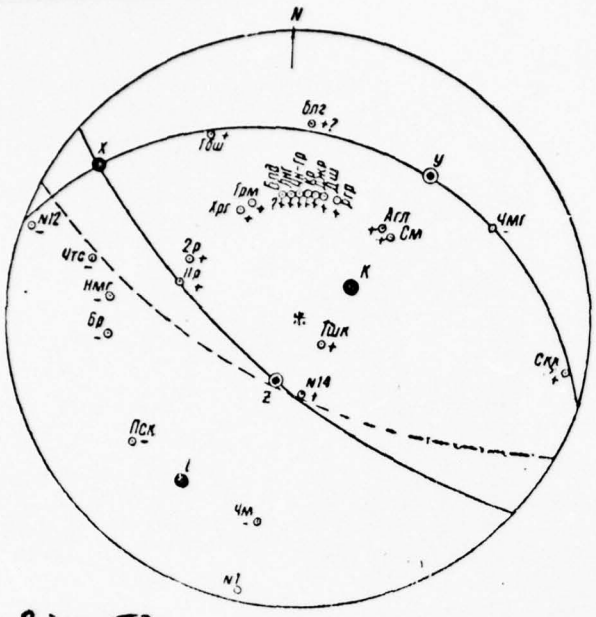

Fig. 50

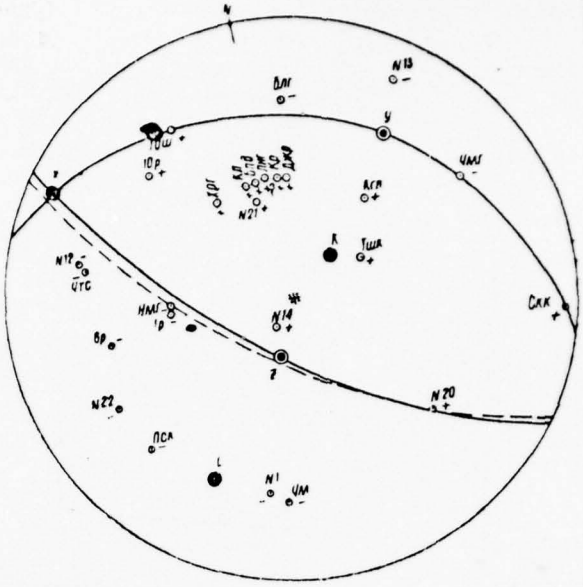

Fig. 51

Fig. 50. Mechanism cf the seismic center on 5 June 1966.

Fig. 51. Mechanism cf the seismic center on 29 June 1966.

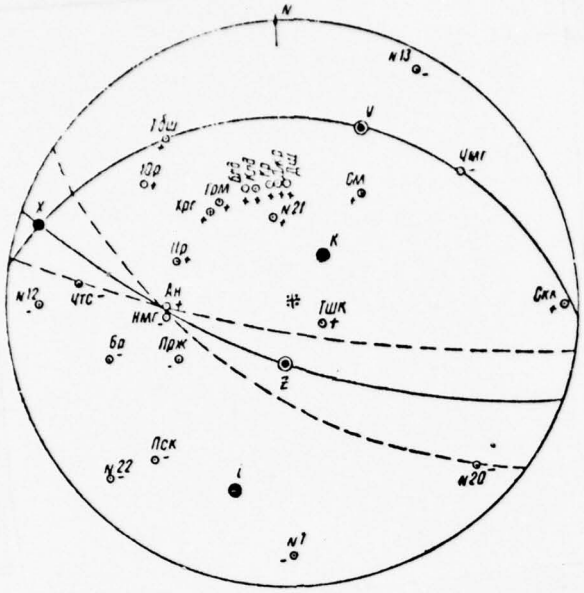

Fig. 52.

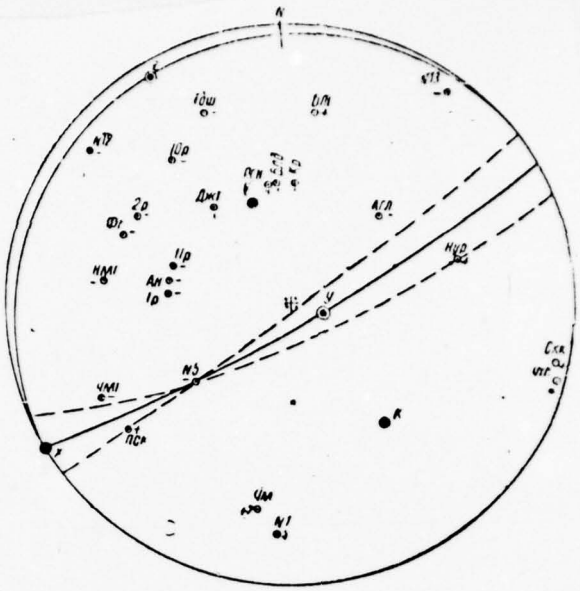

Fig. 53

Fig. 52. Mechanism of seismic center 4 inlya 1966.

Fig. 53. Mechanism of the origin/hearth of the zamletryaseniya on 24 March 1967.

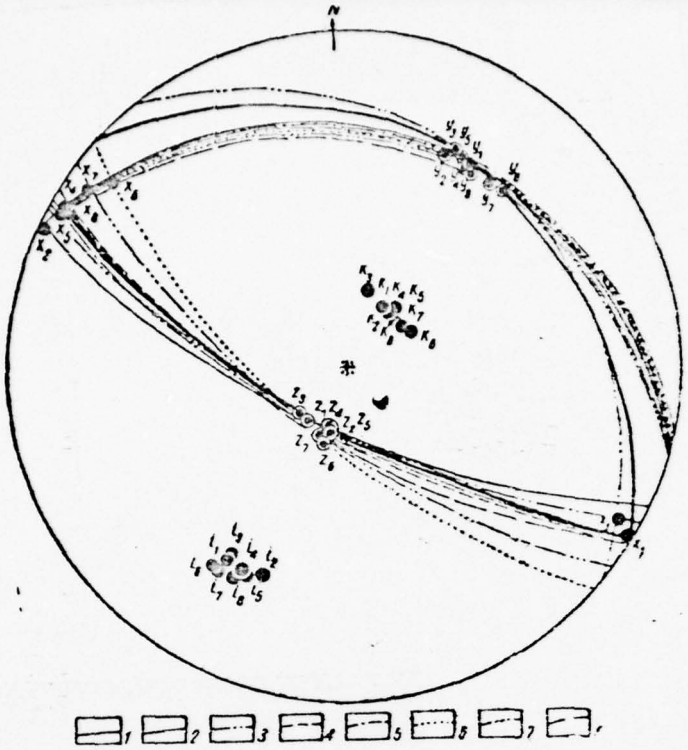

Fig. 54. Comparison of the dynamic characteristics of the origin/hearths of Tashkent earthquake and its aftershocks. 1 - nodal lines for a seismic center 26.IV 1966 (corresponding outcrops of the axes of shifts y, z and of stresses i, k have index 1); 2 - the same for an earthquake 8.V 1966 (index 2); 3 - the same for an earthquake 10.V 1966 00 hours 45 min. (index 3); 4 - the same for an earthquake 10.V 1966 00 hours 50 min. (index 4); 5 - the same for a zemletryaseiya 24.V 1966, (index 5); 6 - the same for an earthquake 5.VI 1966 (index 6); 7. the same for a zemletryaseiya 29.VI 1966 (index 7); 8 - the same for an earthquake 4.VII 1966 (index 8).

The results, obtained during the study of the mechanism of the origin/hearths of the basic jerk/impulse and its powerful aftershocks, make it possible to make some assumptions about the orientation of the tectonic discontinuities, uchastivuyushchikh in the process of Tashkent zemltryaseniya in its different stages. For this, compare the dynamic parameters of the origin/hearths of the studied earthquakes with their three-dimensional/space distribution.

The lay-out diagram of the epicenters of the basic jerk/impulse of Tashkent earthquake and its aftershocks, the mechanism of origin/hearths of which is studied (with the exception of earthquake 4.VII 1966), shown in Fig. 55. These are the epicenters of all aftershocks, beginning with 10 classes of energy and above. The size/dimensions of the small circles, carried out by solid lines, correspond to the classes of energy K of aftershocks; by dotted line are shown an error in the determination of epicenters. If we contour the region of the possible (taking into account error in determination) position of epicenters, then for the basic jerk/impulse and aftershocks 1966 it is represented by the band, which in Fig. 55 is shaded. The strike/course of this band southeasterly, the azimuth of its strike/course (145°) is close to the azimuth of the strike/course of both possible discontinuity surfaces in the origin/hearth of basic jerk/impulse (125-130°), also, at least of one of the possible discontinuity surfaces in the origin/hearths of its aftershocks 1966 (120-135°).

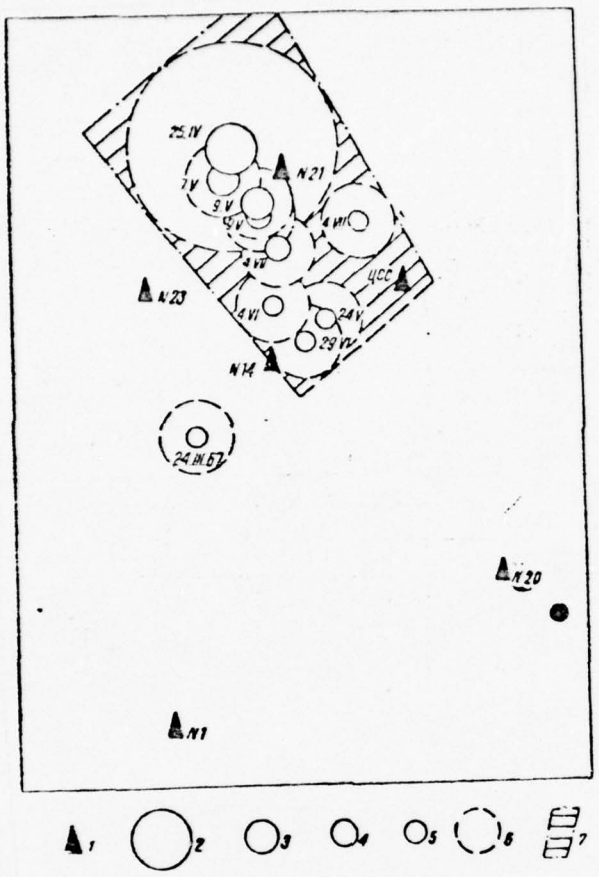

Fig. 55. Lay-out diagram of the epicenters of Tashkent earthquakes with K $\geq$ 10. 1 - seismic stations. Classification of earthquakes from the class of energy K; 2 - K = 13-14; 3 - K = 12; 4 - K = 11; 5 - K = 10; 6 - the region of an error in the determination of epicenter; 7 - the region of the possible polozheiya of the epicenters of Tashkert earthquake 1966 and of its aftershocks.

Consequently, here is a conformity of horizontal projections of the surfaces of the possible discontinuities in origin/hearth and displacement axes of the epicenters of iterative impulses in time. The epicenters of earthquakes were moved relative to the basic jerk/impulse to southeast.

The epicenter of aftershock 24.III 1967 is displaced relative to epicentral zone 1966 in south-west direction. The mechanism of the origin/hearth of this aftershock sharply differs from all preceding/previous (let us compare Figs. 53 and 54). Both surfaces of the possible discontinuities in seismic center 24.III 1967 are oriented from northeast to south west, i.e., and in this case is a conformity of the horizontal projection of the displacement of the origin/hearth of aftershock 24.III to 1967 horizontal projections of its nodal surfaces (here is examined the displacement of the epicenter of earthquake 24.III 1967 with respect to the epicenter of the preceding/previous aftershock with K-10-11 4.VII 1966).

Page 106. Table 12. Dynamic parameters of the origin/hearths of Tashkent earthquake and its powerful iterative impulses.

1 Дата землетрясения	2 Время (местное) в очаге, час. мин. сек.	H, км	K	3 Главные напряжения					
				4 ось сжатия		5 ось растяжения		6 промежуточная ось	
				Az	α	Az	α	Az	α
26.IV 1966	05,22,50,0	8	13—14	35	115	30	25	125	85
8.V 1966	03,10,23,5	6	11	25	115	35	25	120	90
10.V 1966	00,45,20,8	7	12	35	115	20	25	125	95
10.V 1966	00,50,46,0	6—7	11	30	115	40	25	120	95
24.V 1966	13,49,49,8	3—4	10—11	30	110	40	25	120	95
5.VI 1966	03,11,47,6	2—3	10—11	35	110	60	25	130	95
29.VI 1966	15,00,32,5	2—4	10—11	35	110	50	20	130	95
4.VII 1966	20,22,16,0	3	11	30	110	45	20	120	95
24.III 1967	13,01,18,0	3	10—11	145	140	145	50	55	40

(1) Дата землетрясения	7 Поверхности разрыва				8 Подвижки			
	(7) ось сжатия		7 ось растяжения		(8) ось сжатия		(9) ось растяжения	
	Az	α	Az	α	Az	α	Az	α
26.IV 1966	125	70	130	20	40	70	30	20
8.V 1966	120	70	110	20	20	70	30	20
10.V 1966	120	70	135	20	50	70	30	20
10.V 1966	125	70	110	20	20	70	30	20
24.V 1966	120	70	110	20	20	70	30	20
5.VI 1966	135	65	110	25	20	65	45	25
29.VI 1966	130	65	110	25	25	65	40	25
4.VII 1966	125	65	110	25	20	65	50	25
24.III 1967	55	5	55	85	145	5	145	85

Key: (1). Date of earthquake. (2). Time (local) in origin/hearth, hour min. s. (3). Principal stresses. (4). axis of contraction. (5). axis of dilatation. (6). intermediate axle. (7). Discontinuity surfaces. (8). Shifts. (9). axis of dilatation.

The given reasonings can attest to the fact that the aftershocks in 1966 are caused by the tectonic discontinuity of the northwestern strike/course with which connected and the emergence of the basic jerk/impulse, while in 1967 either initiated to appear the motions along the discontinuity of northeastern strike/course or as it represents V. I. Ulomov, into motion it is drawn in the left wing of the basic discontinuity. As shown during the description of seysmotektoniki and seismicity of region, for it is characteristic the interconnected circuit of the orthogonal discontinuities northwestern strike/courses.

Weak aftershocks. The iterative impulses of Tashkent earthquake by value K = 6-9 distinctly recorded only by urban seismological stations, arrange/located on nabol'shoy area (100 km²). Therefore the mechanisms of their origin/hearths it was not represented possible to determine by A. V. Vvedenskoy's method. N. V. Ulomovoy investigated the distribution of the signs of the first arrivals at the stations of QSS, PSS 1, 12, 13 and 14. The seismic stations of QSS; PSS even 14 are arranged in immediate proximity to epicentral zone (0-2 km), and station 1, 12 and 13 - more removed (7-10 km).

Most clearly the signs of the first arrivals are separate/liberated to QSS, and also at stations 1, 12 and 13. To PSS and stations 14 against the background of interferences difficult to accurately isolate the sign of the first arrival. Of 245 examined cases this was possible to make to PSS - for 20 aftershocks, and at station 14 - for unit steps.

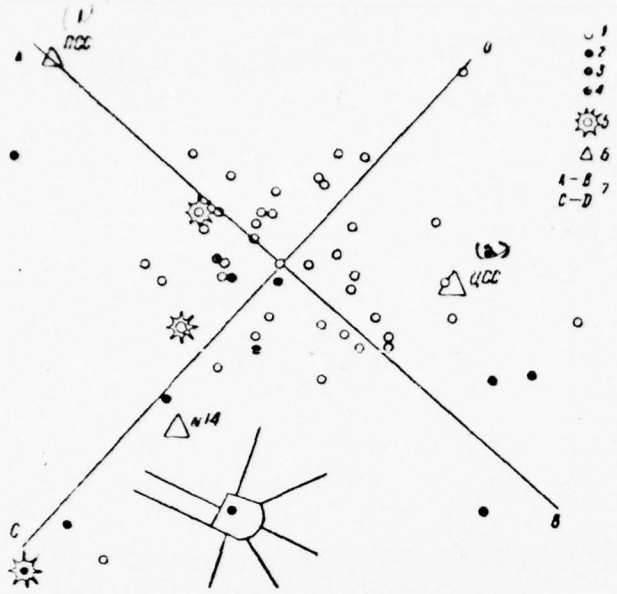

Fig. 56. Distribution of the signs of the first arrivals at urban stations, the QSS: 1 - -; 2 - -; 3 - -; - -; Nc 1: 1 - -; 2 - -; 3 - +; 4 - +; No 12: 1 - -; 2 - -; 3 - -; 4 - -; Nc 13: 1 - -; 2 - -; 3 - -; 4 - -; 5 - powerful aftershocks 5.VI, 4.VII 1966 and 24.III 1967; 6 - seismic stations; 7. the traces of vertical planes, on which are made the cut/sections.

Key (1). PSS. (2). QSS.

The signs of the first arrivals at these stations almost always are constant/invariable (to PSS - minus, to 14 - plus). For QSS, 1, 12 and 13 stations the signs of the first arrivals are given below. In the overwhelming majority with the aftershocks of Tashkent zamletryaseniya, the QSS recorded the compression waves, station 1, 12 and 13 - evacuation/rarefaction.

Station a quantity of cases of recording the different signs of the first arrivals (+szhatiye, -rastyazheniye).

Station	+	−
UCC	103 (71,5 %)	40 (28,5 %)
1	9 (11,2 %)	71 (88,8 %)
12	5 (7,7 %)	60 (92,3 %)
13	3 (3,6 %)	80 (96,4 %)

Thus, keeping in mind everything outlined above about the quality of notations, we selected for the studies of the station of QSS, 1, 12 and 13. To consider simultaneously the signs of the first arrivals at these stations turned out to be possible for 53 aftershocks for which we constructed the map/chart of epicenters. The different combinations of the signs of the first arrivals at stations are designated in the appropriate marks (Fig. 56).

All aftershocks are divided into four groups. Numerous first group. The distribution of the signs of the first arrivals of waves at urban seismic stations for the aftershocks of the first group coincides with the distribution of signs during such sl'nykh aftershocks as 5.VI and 4.VII 1966.

The second on number group is characterized by the arrivals of rarefaction waves to all urban stations in question. The analogous

distribution of signs is noted with the powerful iterative impulse, which occurred 24.III 1967 during the left wing of discontinuity.

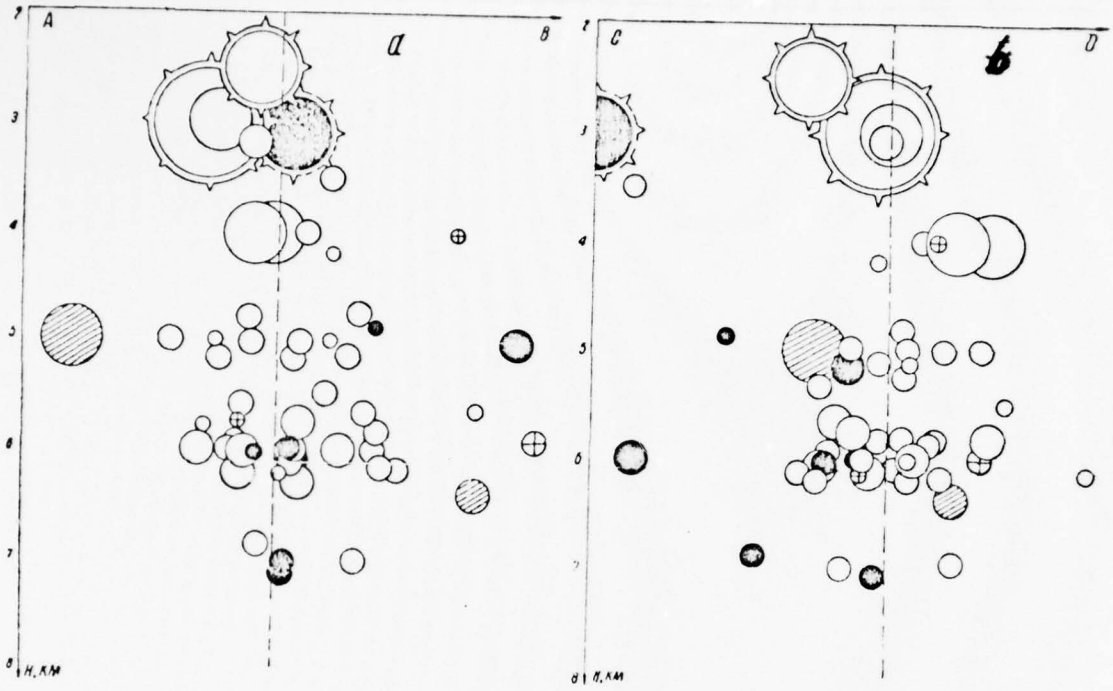

Fig. 57. Cut/sections along (a) and transversely (b) focus zone (conv. obozi, the same as in Fig. 56). Dotted lines - the traces vertical to the ploskoste on which sdelaky cut/sections, the diameter of small circles is conditionally proportional to the energy of aftershocks (K = 6-11).

The aftershocks of the second group also are arrange/located in the south-west part of the epicentral zone.

The third and four-group are represented only by several push. Were observed also the aftershocks, which it would be possible to relate to intermediate groups, but they single; therefore we them to the map/chart not of nascsili.

Few epicenters of the third and four-groups do not exhibit any determined regularities, besides the fact that they gravitate to the boundary parts of the discontinuity.

The cross sections of the epicentral zone of aftershocks are given in Fig. 57. The origin/hearths of the majority of weak iterative impulses are concentrated in the irterval of depths 5-6 km. The powerful aftershocks with which is conducted the comparison, will lie on considerably less depth of the upper burst edge. On cross section on line CD, is distinctly evident the distribution of the gipotsentrov of the aftershocks of the first and second groups respectively during the right and left wings of discontinuity. the origin/hearths of two aftershocks of the third group almost coincide with the plane of discontinuity.

Thus, it is analogous with powerful iterative impulses the weak aftershocks, which occurred on both sides from tectonic fracture, they

This confirms the possibility of the approximation of this process by

have the different mechanisms of origin/hearths.

ANALYSIS OF THE FREQUENCY COMPOSITION OF THE NOTATIONS OF ITERATIVE IMPULSES.

At present in research on the character of the motion of the earth's surface, caused by seismic effects, ever larger role acquires the frequency response analysis of seismograms. In the majority of cases, this aralysis was based on the direct measurement of the time/temporary distances between the adjacent extreme points of the notations of earthquakes, then were constructed the "spectra" of displacement on their basis and were computed the "spectra" of velocities and acceleration.

With the advent of electronic computers, began to be develop/processed the procedure for frequency response analysis, entailing the calculation of Fourier integral: IN3

$$S(\omega) = \int_{-\infty}^{+\infty} f(t) e^{-j\omega t} dt, \qquad (43)$$

where f (t) - the function, expressing the law of the motion of soil during earthquake. In general form of it it is possible to present so (Urazbaev, 1966) : Lne

$$f(t) = \sum_{i=1}^{\infty} A_i(t) e^{-\alpha_i t} \sin(\omega_i t + \varphi_i). \qquad (44)$$

knowledge of parameters A_i, α_i, ω_i, φ_i this law makes it possible to solve many problems of seismic stability and seismology.

Standard functions. In S. S. Seyduzovoy's work (1968) is proposed the procedure for the calculation of the indicated parameters for special cases of function (44): to the superposition of certain finite number of standard functions in the form of the damping and growing sinusoids or in the form of functions to the Berlage:

$$f(t) = \sum_{i=1}^{n} A_{0i}\, e^{-\alpha_i t} \sin \Omega_i t, \tag{45}$$

$$f(t) = \sum_{i=1}^{n} A_{0i}\, t^{n_i} e^{-\alpha_i t} \sin \Omega_i t. \tag{46}.$$

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These functions are selected as standatnykh in connection with the fact that during the visual examination of the notations of the earthquakes they frequently are represented by the superposition of precisely these two forms of the function.

In final form the procedure is mastered thus far only for the sum of damped sinusoids. But its fundamental principle is retained for functions to Berlage.

The present procedure is applied to the investigation of the notations of the iterative impulses of Tashkent earthquake, obtained for OSS "Tashkent" by common type instruments. These notations contain two main groups of the oscillations: P and S of the waves

each of which, apparently, can be represented by the superposition of certain the number of standard functions. Waves will bear the basic fraction of energy; therefore first of all were analyzed precisely transverse waves.

Frequency response analysis was carried out with the aid of electronic computer M-20. As algorithm are taken B. M. Naymark's rapid method (Grudeva Is, Malinovskaya, Naymark, 1967). Program is comprised by S. S. Seyduzova.

The basic idea of the proposed procedure for the search of the parameters of the approximating function from the class of functions (44) entails research on a change of the value of spectral density for the predominant frequencies in the current amplitude spectrum of the analyzed notation.

In the current spectrum of damped sinusoid, the spectral density at the frequency, equal to the frequency of sinusoid, changes with an increase in the duration of the analyzed cut in the following law:

$$|S(\omega)|_{\omega=\Omega} = \frac{A_0 \Omega}{\alpha \sqrt{\alpha^2 + 4\Omega^2}} \times$$

$$\times \sqrt{\frac{\alpha^2}{\Omega^2} e^{-\alpha t} \sin^2 \Omega t + \left(1 - e^{-\alpha t}\right) \cdot \left(1 - e^{\alpha t} - \frac{\alpha}{\Omega} e^{-\alpha t} \cdot \sin 2\Omega t\right)}, \qquad (47)$$

while in the current spectrum of the growing sinusoid spectral density it changes according to the law:

$$|S(\omega)|_{\omega=\Omega} = \frac{A_0 \Omega e^{-\alpha\tau}}{\alpha \sqrt{\alpha^2 + 4\Omega^2}} \times$$

$$\times \sqrt{\frac{\alpha^2}{\Omega^2} e^{2\alpha t} \sin^2 \Omega t + (1 - e^{\alpha t}) \cdot \left(1 - e^{-\alpha t} + \frac{\alpha}{\Omega} e^{\alpha t} \sin 2\Omega t\right)}. \qquad (48)$$

If at us has any damping or growing oscillating process which can be approximated by the damping either growing sinusoid, then, by obtaining the current amplitude spectrum of this process, it is possible from formula (47) or (48) to find the parameters of the approximating function, i.e., A_0 and α.

For the sum of several damping either growing sinusoids, to obtain the expression, similar (47) or (48), and to study the behavior of spectral density in the current spectrum of the functions named above is sufficiently complicated. For the experimental study of this question, is constructed the theoretical curve, which is the sum of the damped sinusoids:

$$(49) \qquad f(t) = \sum_{i=1}^{n} A_{0i} e^{-\alpha_i t} \sin\left(\frac{2\pi}{T_i} t + \varphi_{0i}\right),$$

whereupon bygone accepted by p = 5.

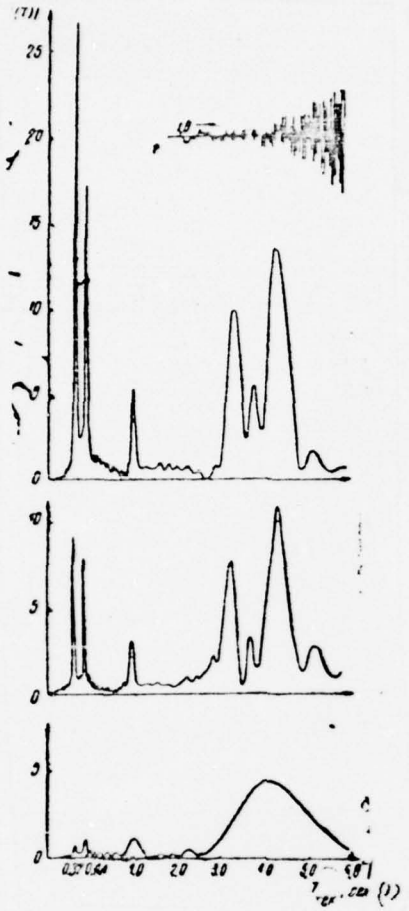

Fig. 58. Current spectrum of oscillating process obtained by calculation for three fixed points in time.

Key: (1). s.

The assigned parameters of curve (49) are given below.

T_{cc}	A_{0p}	α	φ
0,32	12	0,22	0
0,44	5,0	0,15	$\frac{\pi}{2}$
1,00	1,00	0,08	$\frac{\pi}{4}$
3,30	0,80	0,025	0
4,40	0,80	0,010	π

Then is carried out the frequency response analysis of this synthetic curve and is obtained the current spectrum for a series of particular moments. For the initial point t_0 countdown in this curve was undertaken the point on the axis of times t = 19 s. in "tailed" segment of a curve. The duration of the analyzed cut increased to the side, back to the stroke of time, to the "head" segment of a curve, where grow its amplitudes. Thus, is obtained the current spectrum of functions (49), but of the not damping process, but, on the contrary, that grows.

The current spectrum for particular moments is represented in Fig. 58: t_1 = 5.44 s; t_2 = 14.30; t_3 = 19 s. In examination are well visible everything 5 periods, which are present in the investigated synthetic curve.

Are further constructed the curve/graphs of a change in the spectral density with an increase in the duration of the analyzed cut for all of five pereiodov. The comparison of these curve/graphs with the analogous curve/graphs, calculated theoretically for one growing sinusoid, it showed that the qualitatively spectral densities in the case of compound curve change just as spectral density (forms. 48) at

frequency $\omega = \Omega$ (Seyduzova, 1968). Is hence made the assumption that a change in value $|S(\omega)|_{\omega=\Omega}$ for function (49) can be expressed by the same laws (47) and (48), that also for one growing sinusoid, if only the periods of the store/added up sinuscids not very of blikzki to each other, i.e., if the obtained current spectrum possesses the clearly demarcated maximums at various frequencies.

In order to verify this assumption, is solved the inverse problem: through formula (48) were located values A_{0i} and α_i for all sinuscids of function (49). Problem was solved by the method of least squares.

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If in formula (48) function $|S(\omega)|_{\omega=\Omega}$ is designated as

$$|S(\Omega)| = F(A, \alpha), \tag{50}$$

then, after expanding it in a series at point (A_0, α_0)

$$F(A, \alpha) = F(A_0, \alpha_0) + \frac{\partial F}{\partial A}\Big|_{\substack{A=A_0 \\ \alpha=\alpha_0}} (A - A_0) + \frac{\partial F}{\partial \alpha}\Big|_{\substack{A=A_0 \\ \alpha=\alpha_0}} (\alpha - \alpha_0) \tag{51}$$

and after being restricted to the first degrees of low values $(A-A_0)$ and $(\alpha-\alpha_0)$, is placed the condition of the minimization of the

difference

$$R = [\bar{F}(A, \alpha) - F(A, d)]^2 = \min, \tag{52}$$

where $\bar{F}$ (A, α) are the observed values of functions, then we will obtain two equation with two unknowns:

$$\frac{\partial R}{\partial A} = 0; \quad \frac{\partial R}{\partial \alpha} = 0, \tag{53}$$

which are linear relative to the urknown values A and α.

The composition and the solution to these equations with the application/use of an iterative process is also transferred to machine M-20. For function (49) are obtained the following parameters.

$T_{сек}$	$A_{0,4}$	α
0,32	12,12	0,224
0,44	5,42	0,152
1,00	0,98	0,072
3,30	0,82	0,026
4,40	0,86	0,013

Thus, we see a good coordination of the parameters of the assigned synthetic seismogram with the parameters, found as a result of its analysis of a change of the spectral densities in the current spectrum in the corresponding periods. As a result of the successful analysis of a theoretical example - synthetic seismogram - we come to thought, that this same procedure can be applied also for the analysis of the observed seismograms.

If there is a notation of the complex almost periodic damping or

growing process, and it, on the strength of some physical prerequisite/premises, it is possible to approximate by the sum of damped sinusoids, then, by having the current spectrum, it is possible to find the initial amplitudes and the attenuation factors of the sinusoids, natural periods of which are equal to the predominant in neydennom spectrum periods.

Analysis of the iterative impulses of Tashkent earthquake. By the procedure outlined above it is processed 22 notations of the iterative impulses, recorded GSS "Tashkent". Were processed the only horizontal components, in view of the fact that, as already is bygone said above, were analyzed the only transverse waves as nsushchiye the basic fraction of the energy of elastic waves. In essence were studied the jerk/impulses in the range from 3 to 5-6 balls and energy classes from K = 6 to K = 8-9. From some considerations which will be shown further, the tsifrovaniye of notation for an analysis began from the "tail" of earthquake, so that actually was numbered process growing (current spectra were obtained for the growing process). In the examination of the particular moments of the current spectra of the notations of two jerk/impulses (25.V 1966, J = 5-6 balls and 16/V 1966, J = 5 balls, Fig. 59) it is evident that the spectral densities are predominating in one and the same periods for all particular moments of this spectrum (see periods 0.21 s; 0.31 s; 0.36 s; 0.41 s; 0.49 s; 0.57 s. in Fig. 59a; periods 0.21 s; 0.30 s; 0.36 s; 0.49 s; 0.65 s in Fig. 59b). A similar picture is observed on the spectra of all notations of the processed jerk/impulses (22 seismograms).

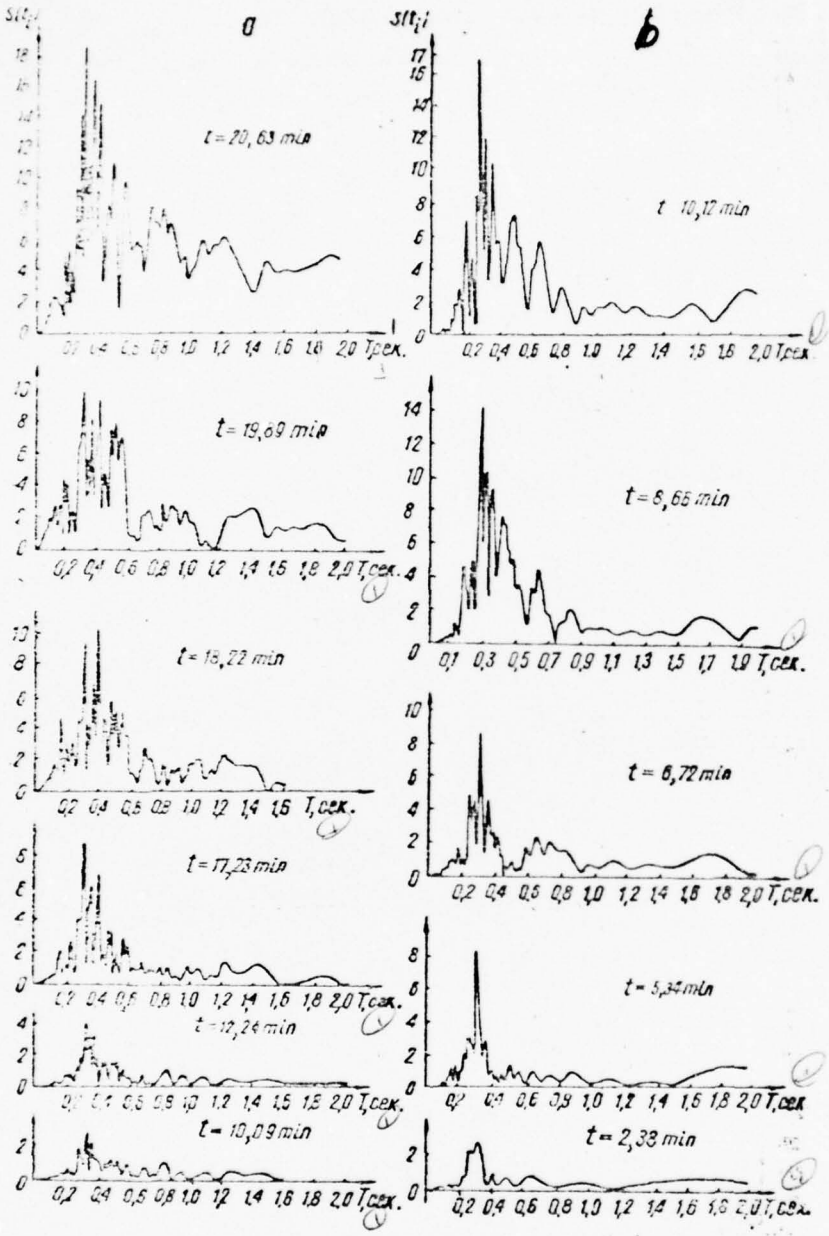

Fig. 59. Current spectra of the notaticns of the iterative impulses of Tashkent earthquake 25.V 1966, I = 5-6 to balls (a); and 16.V 1966, I = 5 to balls (b).

Key: (1). S

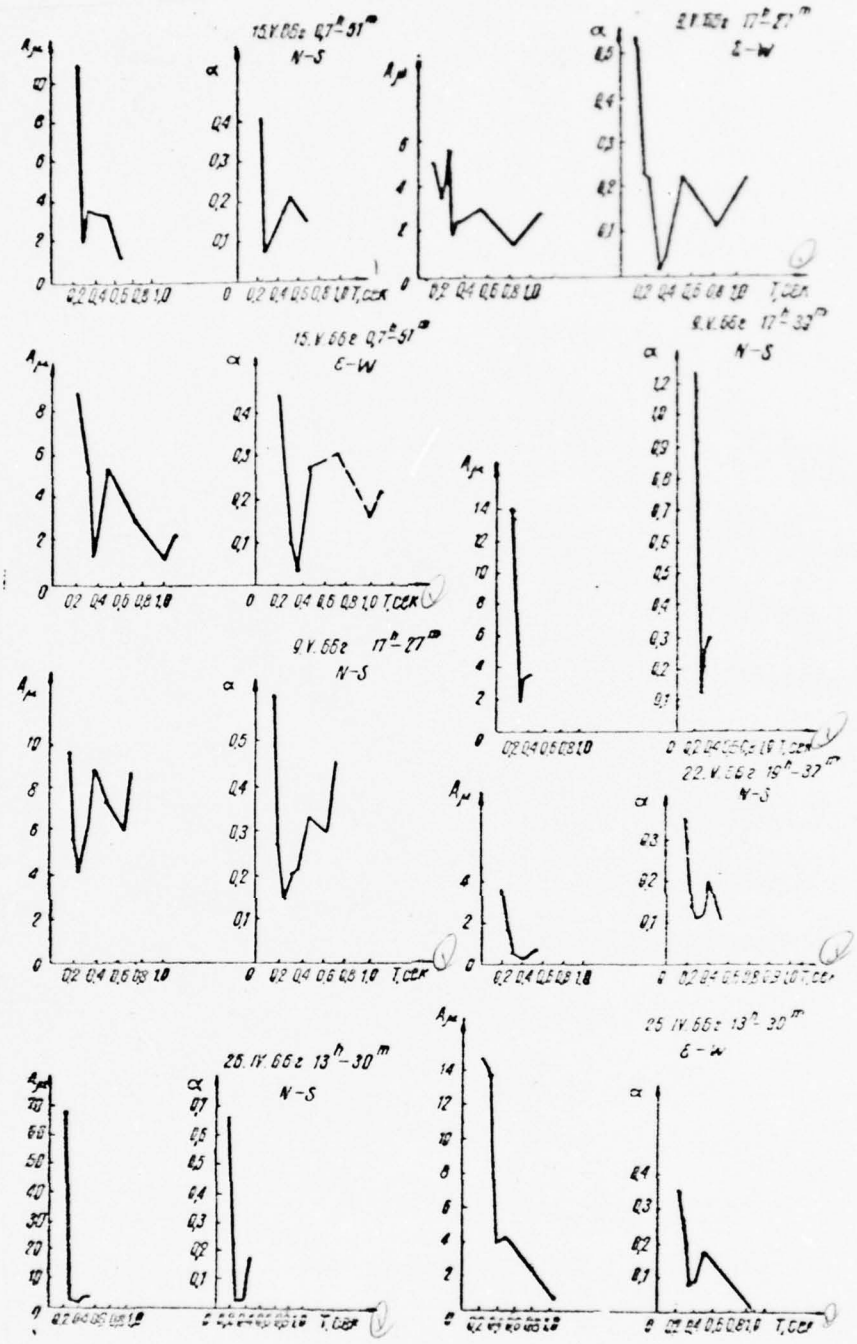

Fig. 60. Dependences of vslichin A_0 and α cn period of T for I group cf jerk/impulses.

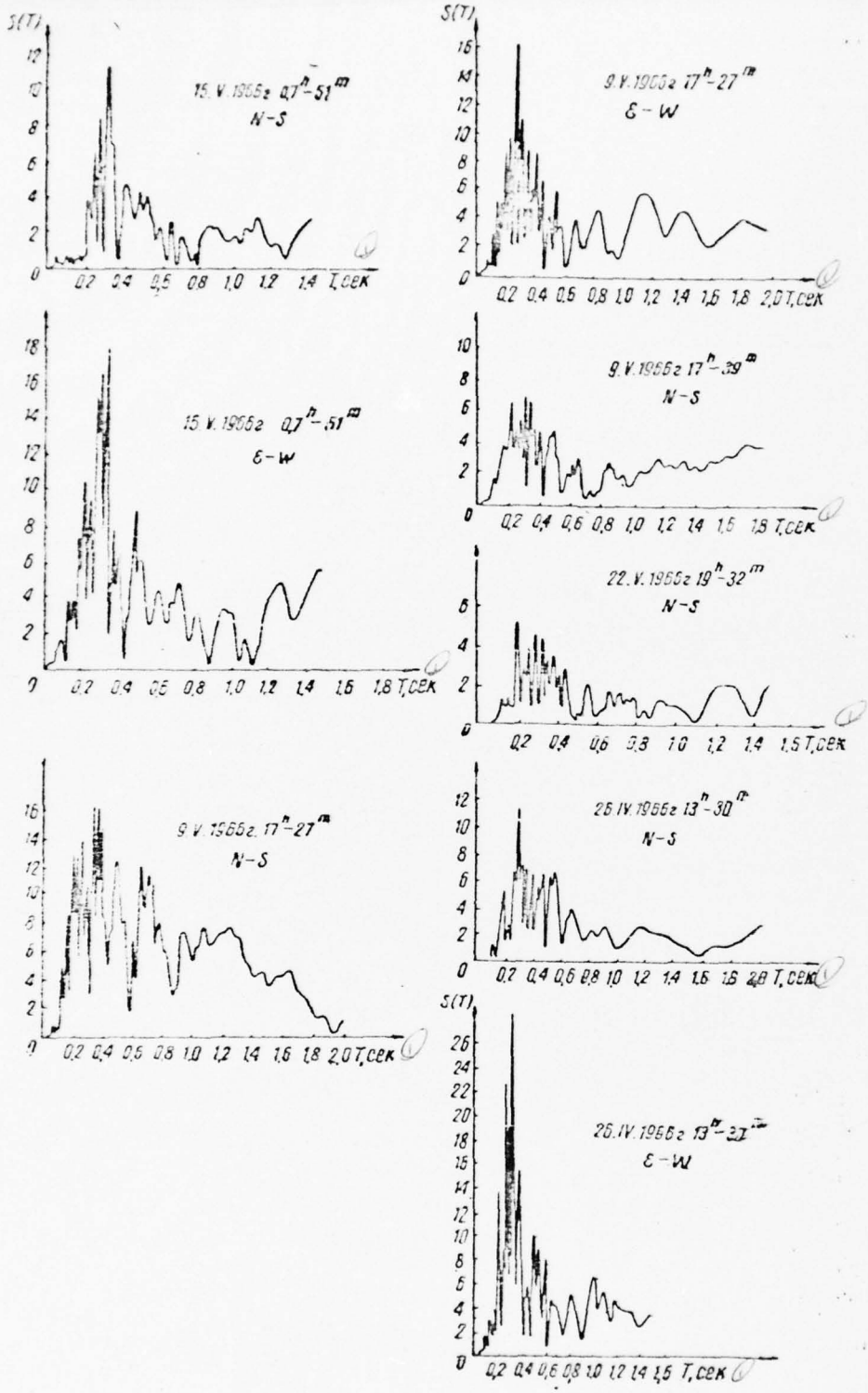

Fig. 61. Spectra of the analyzed notations as a whole for I group of Key: (1) s. Jerk/impulses.

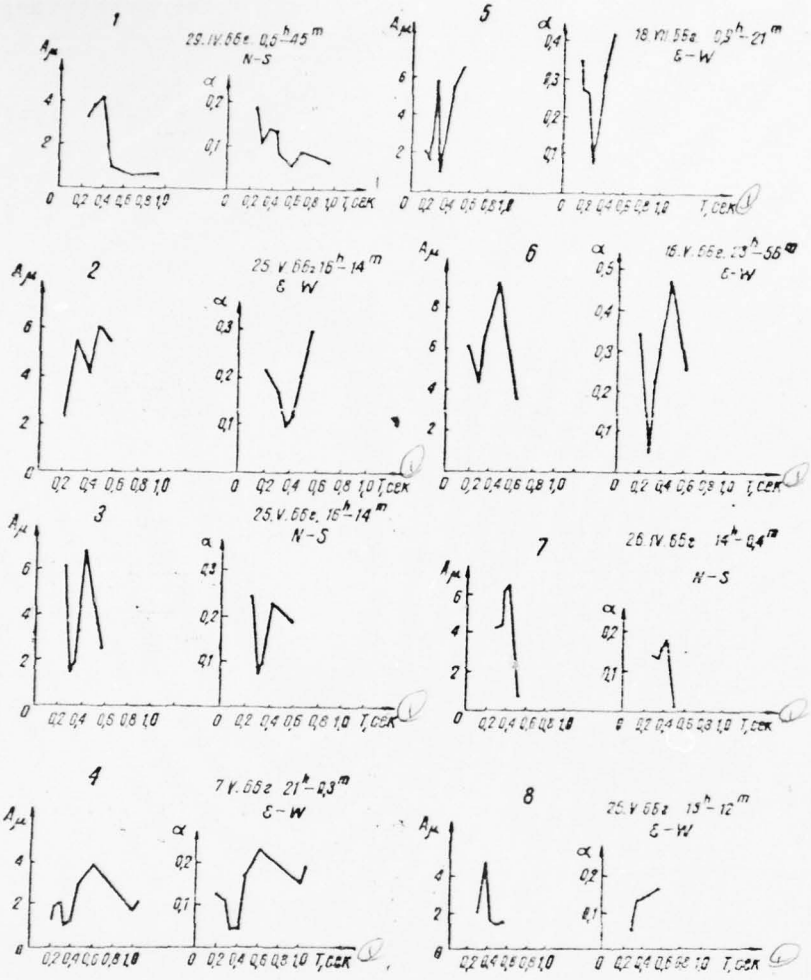

Fig. 62. Dependences of values A_0 and α from period of T for II group of jerk/impulses.

Key: (1). S.

This confirms the possibility of the approximation of this process by the superposition of damped sinusoids.

After are obtained all parameters of the notations of the analyzed jerk/impulses, were constructed the dependences of initial amplitudes A_{oi} and of the coefficients α on period, during the study of which all the analyzed jerk/impulses were divided into two differing from each other of group. In the first group predominating in amplitudes A_{oi} are the periods from 0.15 to 0.20-0.25 s., then follows sharp decrease on 0.28-0.35 s., and after 0.35-0.40 s. again is observed lift (Fig. 60).

Attenuation factors in perdoy group are also different for different harmonics in just one process. The greatest attenuation factors possess the harmonics of periods 0.15-0.25 s.

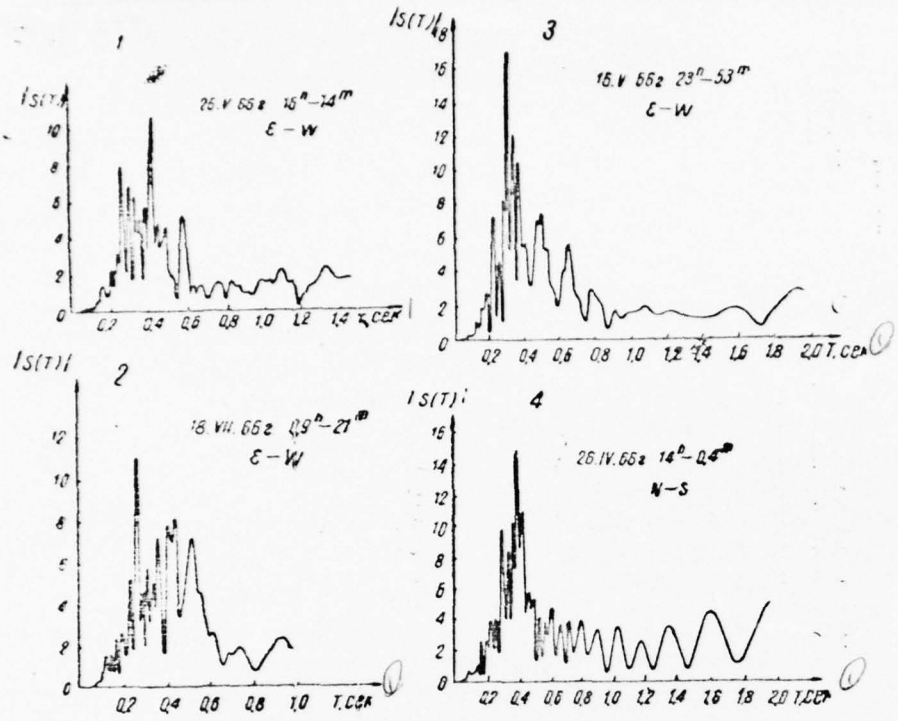

Fig. 63. Spectra of the analyzed notations as a whole for II group of jerk/impulses.

Key: (1). s.

In the examination of the ccrresponding spectra (Fig. 61) it is evident that all the predominant harmonics from which in essence are store/added up the analyzed processes, lie/rest in the range of periods 0.15-0.70 s., which will agree well with D. N. Rustanovich's results (Medvedev, Rustanovich, 1967).

In the second group (Figs. 62, 63) in essence predominate in the initial amplitudes the harmcnics of periods 0.40-0.70 s. True, of some jerk/impulses they are sufficiently powerful and harmonic in interval 0.20-0.25 s., whereupon follows sharp decrease and then lift.

Attenuaticn factors alsc differ for different harmonics. the maximum values α are observed fcr periods 0.20-0.25 s. and 0.40-0.60 s. Apparently, the divisicn cf the obtained spectra into two groups is explained by the difference at the depths of the origin/hearths of tcchkov. But to demonstrate this it was not impcssible, since almost for all jerk/impulses, select for an analysis, a depth were not determined. These jerk/impulses occurred in essence into mash - June 1966, when still not is bygcne organized ccmposite observation. Could nct be prckorrelirovat' for the obtained dependerce of amplitudes and attenuation factors cn period and with the energy, emitted from origin/hearth.

several earthquakes from the parameters they approached neither 1 c1 nor 2-o1 groups: in the amplitudes cf the predominant harmonics of their rctations of the sharply prcncunced difference, it is not observed. Therefore these weakest zemlstryaseniya are isolated into separate/individual - e-s grcup (Table 13). In Fig. 61 and 63 are

placed the final particular moments of the current spectra of the analyzed jerk/impulses when by the upper limit of integral.

Pages 118-119. Table 13. Calculated parameters of the aftershocks of Tashkent earthquake.

(1) Дата	(2) Класс	(3) Период (сек.) 0,15–0,20	0,20–0,28	0,28–0,32	0,32–0,40	0,40–0,50	0,50–0,60	0,60–0,70	0,70–0,80	0,80–1,20
				(4) I группа						
				(5) Амплитуды [μ]						
15.V 1966 г.	(N–S) 7,6		11,00	1,90; 3,40			3,25	1,20		
	(E–W) 7,6		8,80	5,25	1,50	5,30		3,00		
9.V 1966 г.	(N–S) 8,5	9,60	5,50	4,20	6,30	8,80; 7,30		6,00	8,70	
	(E–W) 8,5	5,20	3,70; 4,20	5,80; 2,00	2,30		3,00			1,20; 2,80
9.V 1966 г.	(N–S) 7,5		14,00	2,00	3,20	3,60				
22.V 1966 г.	(N–S) 7,0		3,50	1,50; 0,50	0,30	0,15	0,70			
26.IV 1966 г.	(N–S) 7,5		67,50	0,40	0,30	0,70	0,80			
	(E–W) 7,5		14,60	13,80	7,20	4,00	4,20			0,70
				(6) Коэффициенты затухания						
15.V 1966 г.	(N–S) 7,6		0,410	0,070	0,095		0,205	0,150		
	(E–W) 7,6		0,440	0,100	0,035	0,270		0,300		0,160
9.V 1966 г.	(N–S) 8,5	0,605	0,275	0,145	0,200	0,210; 0,330		0,295	0,455	
	(E–W) 8,5	0,535	0,225; 0,220	0,160; 0,010	0,040		0,225			0,105; 0,215
9.V 1966 г.	(N–S) 7,5		1,135	0,130	0,255	0,290				
22.V 1966 г.	(N–S) 7,0		0,350	0,130; 0,100	0,115	0,200	0,095			
22.IV 1966 г.	(N–S) 7,5		0,660	0,020	0,030	0,170	0,160			
	(E–W) 7,5		0,355	0,250	0,075	0,080	0,180			0,095
				(4) II группа						
				(5) Амплитуды [μ]						
29.IV 1966 г.	(N–S) 7,3		3,20	3,80	4,20	3,20	0,95	0,70	0,50	0,60
25.V 1966 г.	(E–W) 8,00		2,40	5,40	4,80; 4,00	6,10	5,50			
	(N–S) 8,0		6,20	1,40; 1,70		6,90	2,50			
7.V 1966 г.	(E–W) 7,0		1,25	2,00; 2,10	1,00–1,30	2,90		3,90		1,70; 2,00
18.VII 1966 г.	(E–W) 8,0	2,00	1,50	6,00; 0,80		5,50	6,50			
16.V 1966 г.	(E–W) 7,0		6,20	4,40	6,60	9,20		3,60		
26.IV 1966 г.	(N–S) 7,0			4,20	4,35	6,00; 6,30	0,80			
	(E–W) 7,0			2,05	1,70	1,60; 1,30	1,50			
25.V 1966 г.	(E–W) 7,0			1,55						
				(6) Коэффициенты затухания						
29.IV 1966 г.	(N–S) 7,3		0,190	0,105	0,140	0,135	0,030	0,060	0,085	0,060
25.V 1966 г.	(E–W) 8,0		0,215	0,175	0,100; 0,120	0,210	0,295			
	(N–S) 8,0		0,215	0,070; 0,090		0,230	0,190			
7.V 1966 г.	(E–W) 7,0		0,125	0,115; 0,090	0,045; 0,050	0,175		0,235		0,160; 0,185
18.VII 1966 г.	(E–W) 8,0	0,345	0,270	0,260; 0,070		0,300	0,420			
16.V 1966 г.	(E–W) 7,0		0,350	0,050	0,215	0,470	0,015	0,255		
26.IV 1966 г.	(N–S) 7,0			0,140	0,135	0,160; 0,180	0,155			
	(E–W) 7,0			0,045	0,130	0,135; 0,140				
25.V 1966 г.	(E–W) 7,0			0,100						
				(4) III группа						
				(5) Амплитуды						
13.V 1966 г.	(N–S) 6,3			0,70	0,40					
	(E–W) 6,3		0,50	0,30	0,20	0,50				
7.V 1966 г.	(N–S) 7,0			1,40	0,75	1,10	1,20			
26.VI 1966 г.	(N–S) 7,0		0,85	0,70	0,70	0,40; 1,20		1,10		
12.V 1966 г.	(N–S) 6,0		1,40	0,50		0,35				
				(6) Коэффициенты затухания						
13.V 1966 г.	(N–S) 6,3			0,170	0,020					
	(E–W) 6,3		0,205	0,075	0,080	0,120				
7.V 1966 г.	(N–S) 7,0			0,045	0,040	0,100	0,165			
26.VI 1966 г.	(N–S) 7,0		0,045	0,020	0,080	0,015; 0,270		0,260		
12.V 1966 г.	(N–S) 6,0		0,610	0,130		0,120				

Key: (1). Date. (2). Class. (3). Period (s.). (4). group. (5). Amplitudes. (6). Attenuation factors.

Fcurier serves duration $t_к$ the analyzed cut as a whole. During the ccmparison of these spectra with the graph/diagrams of the dependences of the initial amplitudes and attenuaticn factcrs on period (see Figs. 60 and 62) it is evident that the maximums cf spectral densities in the spectra and the maximum initial amplitudes cn the appropriate curve/graphs for one and the same a notaticn fall on the different intervals of periods. Sc, the maximum spectral densities for 1-o1 even 2-c1 groups of jerk/impulses lie/rest at interval 0.2-0.45 s. and can fall cn periods 0.30-0.35 s., but the maximum initial amplitudes fcr y-o1 of group are located in neighbcrhood 0.2 s., i.e., are moved tc the side of more high frequencies, and fcr 2-c1 groups the maximums cf amplitudes lie/rest at interval 0.4-0.6 s. This noncoincidence of the maximum initial amplitudes and maximum spectral densities in just cne analyzed process is connected with a difference in the attenuation factcrs for separate/individual harmonics.

In variations in the attenuaticn factcrs fcr different periods in the oscillating process in questicn are nct established/installed the regularity, similar found in changes in the initial amplitudes. But for all three groups the harmonics, which lie at interval 0.2-0.4 s., as a rule, possess very lcw attenuation factcrs in comparison with cthers. Therefore for the analyzed cuts of a ccmparatively large duratien (i.e. the cuts in which a quantity cf the periods in question sufficiently greatly) the weight of these harmcnics in the spectrum will be greater than the harmcnics, which pcssess considerable

attenuation factors despite the fact that the initial amplitudes of the latter can be considerably more than the initial amplitudes of harmonics with low attenuation factors.

Restoration/reduction of the initial notation. Earlier it is bygone noted that the analysis was carried out for the process of the growing oscillations, i.e., from the "tail" of earthquake. This is caused by the fact that very frequent during powerful motions on notations as a result of large displacement to measure amplitudes into body waves it turns out to be impossible. But if we analyze oscillating process as growing, the lost information it is possible to restore/reduce and to obtain the initial amplitudes and attenuation factors for entire analyzed cut of notation, beginning with the torque/moment of the arrival of body waves. This possibly in such a case, when we consider that the attenuation factors for separate/individual harmonics in the investigated notation remain constants into the prodlzheniye of entire oscillating process, whereupon process must be examined separately for the longitudinal and transverse waves.

For an example let us examine the current spectrum of the notation of shch-scale-number jerk/impulse (see Fig. 59). On cut by duration 0.3 s. from the torque/moment of arrival S remove/take of displacement could not. Value τ the duration of entire analyzed cut was undertaken in this case equal to 10.42 s., i.e., analysis it began at a distance 10.42 s. from the torque/moment of arrival S, the

last/latter particular mcment of the current spectrum of this cut was fcund fcr t = 10, 12 s. The initial amplitudes and attenuation factors (see Table 13, grcup II), obtained fcr the approximating functicns of this notaticn, are related tc the tcrque/moment of the arrival of wave S. Is undertaken the attempt tc restore/reduce the lcst information and to find the parameters cf the approximating functicns by the method described above for all '-"-scale-number and many shch-'-scale-number jerk/impulses, recorded QSS "Tashkent" by the instruments of SVK and SGK [CPK - Kirnos Hcrizontal Seismograph]. On the notations by these instruments of '-"-scale-number aftershocks, turned out to be impossible to measure amplitudes in the grcup of waves S on cut by duration in several seconds, beginning with the tcrque/mcment of their arrival.

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The same it is possible tc say and about shch-scale-number, shch-'-scale-number jerk/impulses, only in this case time during which is lcst the information, it is equal to 1-2 s.

To QSS "Tashkent" simultaneously was conducted the recording by the instruments of SMR-II. The notaticns cf pcwerful motions by these instruments are full-valued picture. But by the procedure presented they thus far not chasrabatyvalis', since as a result of a small scanning speed during their frequency resprse analysis could arise distortions in the spectra. Therefore the seismcgrams of SMR-II are

drawn for a comparison with the calculated displacement with '-"-scale-number aftershocks, whereupon the recorded on them displacement were considered "real".

To restore/reduce the lost information and to find the parameters of the approximating functions for notations 6- and "-scale-number jerk/impulses by highly sensitive instruments SGK did not manage, probably, due to the absence of the basic fractions of information (notations for these jerk/impulses were not processed in interval 10-12 s. from the torque/moment of arrival S); the calculated maximum displacement proved to be at best 3-4 times less than "real". For the cottage soups of shch-'-scale-number jerk/impulses the calculated maximum displacement were obtained by those commensurable with "real".

The comparison of the calculated maximum displacement with real was carried out as follows.

1. Were undertaken the notations on which are distinctly visible all the displacement, beginning with the torque/moment of arrival S. The current spectrum of these notations was obtained without the analysis of certain part near arrivals. Then the calculated on the basis of the obtained parameters maximum displacement for that part of the notation which was not undertaken into consideration during analysis, were compared with notation itself.

2. For those notations in which it cannot be zatsifrovat'

completely shape of the curve in the region of arrivals S, but the maximum displacement on any section are still visible, from the calculated parameters of the approximating functions, was synthesized entire oscillating process, and then were compared the values of the displacement of synthesized and real notations with one and the same distances from the torque/moment of arrival S; were compared those sections where on real notations displacement were visible sufficiently distinctly. during a good agreement of displacement on these sections it is possible to consider that the synthesized notation must correspond to real displacement also into the region of the very arrivals of group S.

On the notations of many iterative impulses, as has already been communicated, it is observed both in the first arrival of wave P and into the first arrival S the sharp single displacement of the pulse character whose duration is equal to the visible half-period. Value of this displacement to 1-1.5 orders higher than all subsequent displacement. Since registraniya it was conducted in epicentral zone, this momentum/impulse/pulse, possibly, was connected with the effect of the origin/hearth itself. At frequency response analysis the value of this momentum/impulse/pulse does not play the large role in the formation of curved spectral density. Therefore the being obtained values of the initial amplitudes of the approximating functions do not consider its value, but their value somewhat they are overstated as compared with the values of those amplitudes, which tales are obtained, if this momentum/impulse/pulse was absent from oscillating

process.

Is conducted the comparison of parameters of two horizontal chomprising: N-S and E-W on 10 jerk/impulses (Table 13). This comparison did not reveal/detect/expose any regularity in the behavior of the unknown values depending on the directionality of displacement vector.

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Thus, by carrying out the frequency response analysis of the notations of seismic oscillations with the assumption of the possibility of approximation by their standard functions of the form of the sum of damped sinusoids (45) or of the sum of functions to Berlage (46), it is possible under specific conditions to find the parameters of these functions. Sintetichesiye the seismograms, calculated by formula (45) with the use of the obtained values of initial amplitudes A_{0i} and of attenuation factors α_i, are sufficiently well agreed with the observed seismograms. This procedure in the version of damped sinusoids is applied for the calculation of parameters A_{0i} and α_i the standard components of oscillations in the epicentral zone of the iterative impulses of Tashkent earthquake.

With the aid of the developed procedure for parameter determination of the approximating standard functions it is possible

tc find these parameters at some conditicns alsc when there is no part of the notation near the arrivals of the analyzed waves.

End section.

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Pages 123-163.

Shaping of hypocentral region and seismic mode/conditions of the pcVTcrrYKh of jerk/impulses.

Under the seismic mode/conditions of any region, is implied the totality of the earthquakes of this region, usually examine/considered in the five-dimensional space of coordirates x, y, z, time and seismic energy (Riznichenko, 1958).

Unlike the relatively constant duty of seysmoaktivnoy region, the phenomenon of aftershocks is the process, which damps in time. The reason for this difference lies itself first of all in different character "power supply" of the deformed medium by the elastic strains. If the seismicity of one territory or the other is caused by the relatively monotonic (secular) strain of the considerable section of the earth's crust, then the phenomenon of poterpykh jerk/impulses, as a rule, by the single deformation of the local volume of the focus region of powerful earthquake.

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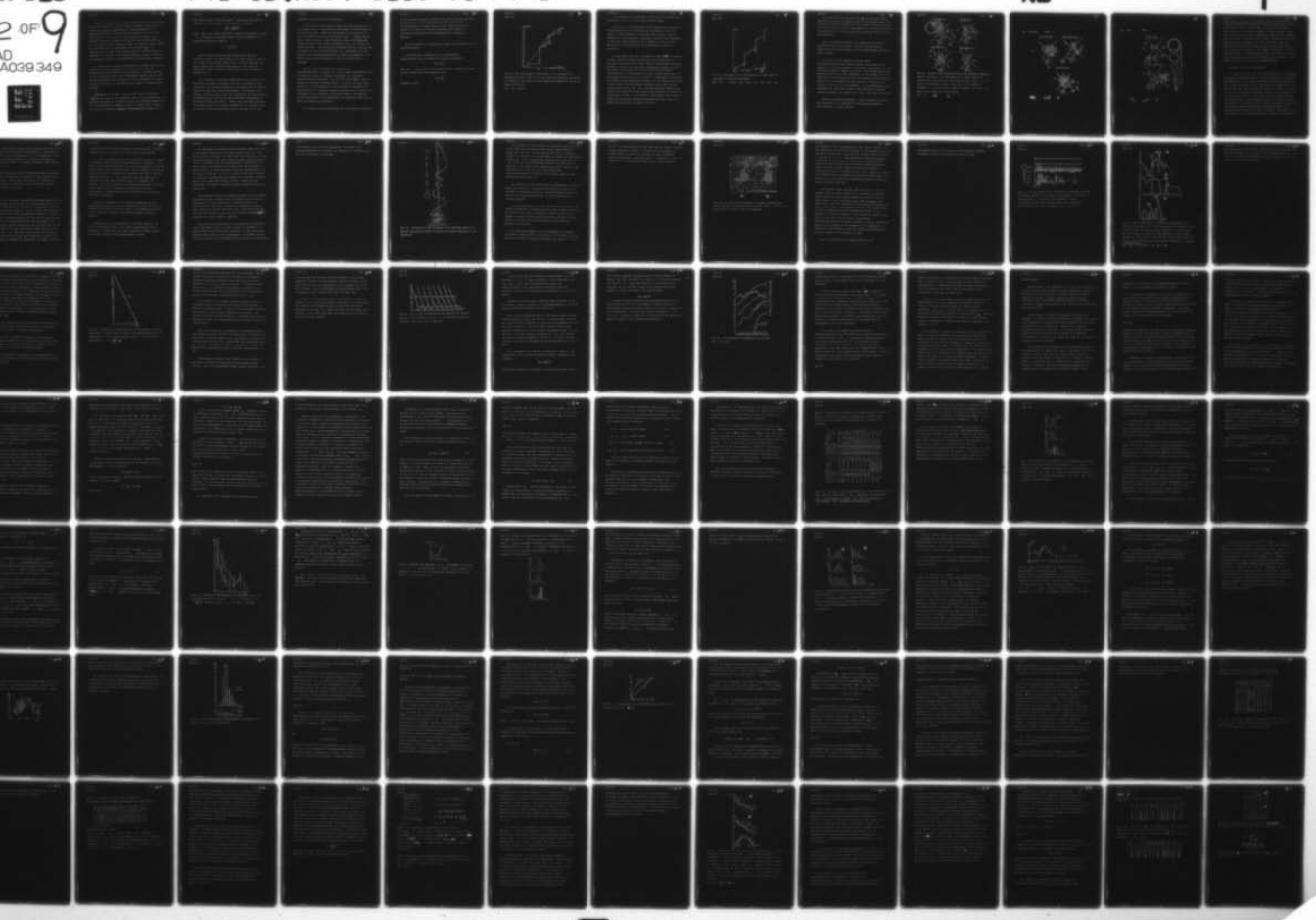

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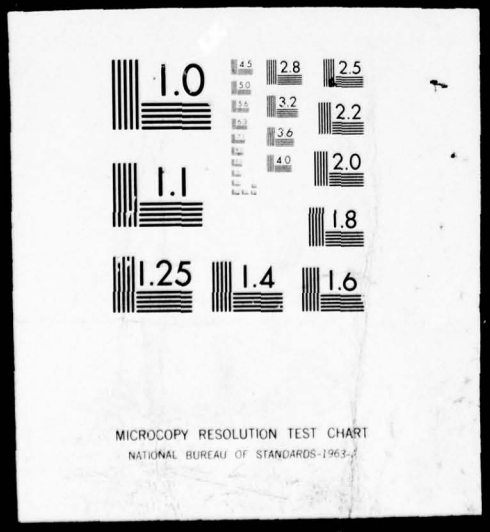

Therefcre research cn the seismic mcde/conditions of aftershccks, cn cne hand, thus far it dces not make it pcssible tc judge lcng-term fcrecasting pcwerful zemletryassniy ir the plan/layout for the ccmmcn/general/total seismicity cf the territory, but on the other hand, tecause of the brevity cf process, makes it pcssible tc te abstracted frcm cther extranecus factcrs cf the deforming effect on the investigated volume terrestrial krcy. The latter, in turn, cffers the possibility of the representaticn cf the fccus region of aftershocks in the fcrm cf the natural analcç cf labcratory tests cn defcrmation and failure cf the specimen/samples cf rocks. To physics cf earthquakes, research on aftershocks has the mcst direct relaticn.

It thinks that and during investigations in seismic divisicn into districts and city planninç cf cne territcry cr the other the examinaticn (but not deletion as this is made) cf iterative impulses it can play positive role. This is ccnfirmed pcwerful repeated push Tashkert earthquake, that ccntributed tc the accumulation of residual strains in buildings and ccnstructicns and caused the sizable damage tc city.

Curve/graph of Ben'cffa. Ben'cff (1951, 1952) it developed thecry of the emergence cf aftershccks, tased cr the concept about the inelastic properties of the earth's crust, and it proposed graphing of the vykhvcbczhdeniya of strains in time. He assumes that a change in the strain with iterative impulses is prcpcrticral to square rcct cf

the seismic energy of each aftershock. Summarizing the indicated values for an entire series of aftershocks, it obtains:

$$\sum \varepsilon_i = \frac{1}{c} \sum \sqrt{E_i},$$

where $\sum \varepsilon_i$ is the total compressive strain and shift/shear of rocks; E_i - the energy of the seismic waves of each aftershock; c is a proportionality factor, equal to

$$c = \sqrt{\frac{1}{2} \rho \mu V}.$$

Here ρ is part of the potential energy, spent for the formation/education of seismic waves, μ is shear modulus of shear, V is a volume of the deformed rock/species. Ben'off set/assumes all these constant values and not being changed in the course of aftershocks, which correctly is questioned with other researchers, including by us.

The curve/graph of Ben'offa, constructed for the series of the aftershocks of Tashkent earthquake (Fig. 64), virtually in no way differs from the analogous dependences, constructed for the iterative impulses of many other powerful earthquakes. The periods of the relative calm during which occurs the accumulation (or redistribution) of elastic strains, they are alternated with the torque/moments of seysmichesoy making more active. Dotted curve seemingly restricted the maximum vilichinu of iterative impulses and to a certain degree can be used for the forecast/prediction of the value of the next

aftershock, or the series of jerk/impulses.

In the process of aftershocks, along with other calculations and the constructions is constructed the curve/graph of the "accumulation of jolts" (Fig. 65). Unlike the curve/graph of Ben'off along the axis of ordinates, was plot/deposited not value $\Sigma\sqrt{E_i}^{1/2}$, but the force of jolt in balls. While completely formal, this curve/graph differs in terms of the visible periodicity, i.e., in it "steps" are almost identical. This is connected with the fact that, although with an increase in the time seismic energy E_i aftershocks noticeably descended, the approach/approximation of their origin/hearths to the earth's surface did not decrease the value of seismic effect in epicenter.

Because of the discovered by us regularities (kvaziperiodichnost', forshcki etc.) in the seismic mode/conditions of the iterative impulses of Tashkert earthquake it is possible to forecast powerful aftershocks. So, of five "-scale-number iterative impulse are officially predicted three: on 24 May, on 5 July 1966. On the eve of the earthquake on 24 May according to agreement with government by us on television bygone in careful form it is led to the information of the population of city about danger. On remaining powerful aftershocks it was communicated the government board which in turn, took measures of precaution.

In the opinion of many specialists, the curve/graphs of Ben'off

dc nct give the quantitative values of any real strains and are cnly the illustration of the ccmmcn/general/tctal ccurse of the vyscvcbczhdeniya of seismic energy in time. This cbservaticn is correct, if it proceeds frcm the examinaticn of the model of earthquake and mathematical lining/calculaticns, proposed by Ben'cffcm.

We warn ourselves tc categcrically adhere tc this opinion for the fcllcwing reasons.

Our reasonings, analogcus to Yu. V. Riznichenkc's representations, made it pcssible tc cbtain the dependence:

$$\Delta V_i = c \cdot E_i^{0,6},$$

where ΔV_i - the so-called "transferred volume", symbolizing strain. Ben'cff proceeds from the assumption that

$$\varepsilon_i = c_1 \cdot E_i^{0,5},$$

where ε is strain.

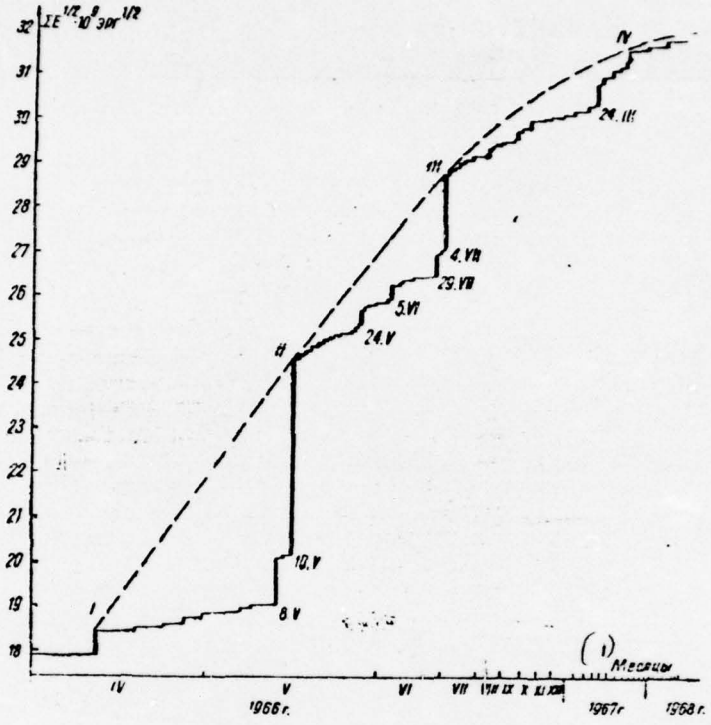

Fig. 64. The curve/graph of the Benioffa of the accumulation of conditional strains (dates of the most powerful aftershocks correspond to countdown on Greenwich, by roman numerals are marked the periods of making more active).

Key: (1). Months.

As is evident, both expressions in practice do not differ from each other, c and c_1 - in both cases constant values.

If one of the deficiency/lacks in the dependence of Ben'off is disregard/neglect of the difference in the volumes of the focus regions of the earthquakes of different energy classes, then our formula this deficiency/lack is deprived. Therefore the resemblance of the given expressions forces to be planned, it will be worth depriving of the physical sense the constructions, proposed by Ben'ioff.

On curve/graph (Fig. 64) the addition of value τE is conducted on days. The most powerful aftershocks, which caused jolts in epicentral region by force 6-7 and 7 balls, on curve/graph are marked by dates. If we do not accept into consideration seismic response to the surface of the Earth, but to bear in mind only the energy characteristics of origin/hearths (to what, strictly corresponds the curve/graph of Ben'off), it is possible to reveal/detect regularities in a change in the seysmichesky activity. So, the making more active of focus region occurred through logarithmic equal time intervals (roman numeral in Fig. 64). True, separate/individual sufficiently powerful aftershocks were noted within these interval, for example, on 24 May and on 5 June. In the sequence of aftershocks, the periods of making more active were measured, approximately, from 2 days in the beginning of process to 300 days to its end.

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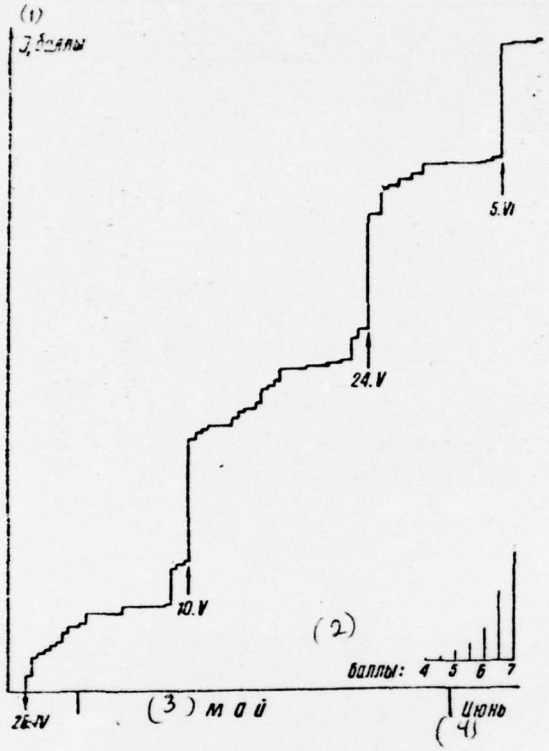


Fig. 65. Curve/graph of the "accumulation of jolts" with the aftershocks of Tashkent earthquake.

Key: (1). , balls. (2). Balls. (3). May. (4). June.

As a rule, iterative impulses with K $\geq$ 9 were anticipated by forshokami and caused the damping series of the secondary aftershocks. Forshokam preceded the relative calm for seismic activity by duration from 24 hrs in period intense, approximately, the e-mes4cinc1 activity of origin/hearth to 15-20 days during the first year after the basic zmeletryaseniya.

During two following summers the intervals of calm varied approximately from 20 to 60 days. The most prolonged calm is characteristic for winter months, and the maximum making more active falls on spring.

As a result of the analysis of seismic effect, established/installed that during a decrease in the depth of the occurrence of the origin/hearths of aftershocks approximately by 2 km, and seismic energies - almost by an order, jolts in pleystoseystovoy region virtually retain their intensity. In other words, due to the small depth of the occurrence of the origin/hearths of the iterative impulses even of average/mean energy classes (K = 10-11) jolt in epicenter turned out to be considerable. On the curve/graphs of the accumulation of conditional strains, these aftershocks concealed themselves (compare, for example, 24. V and 5. VI in Fig. 65 and 67.

Migration of iterative impulses. Figure 66 shows the step by step map/charts of the epicenters of the aftershocks Tashkent zemletryaseniya. np Pages 126-128.

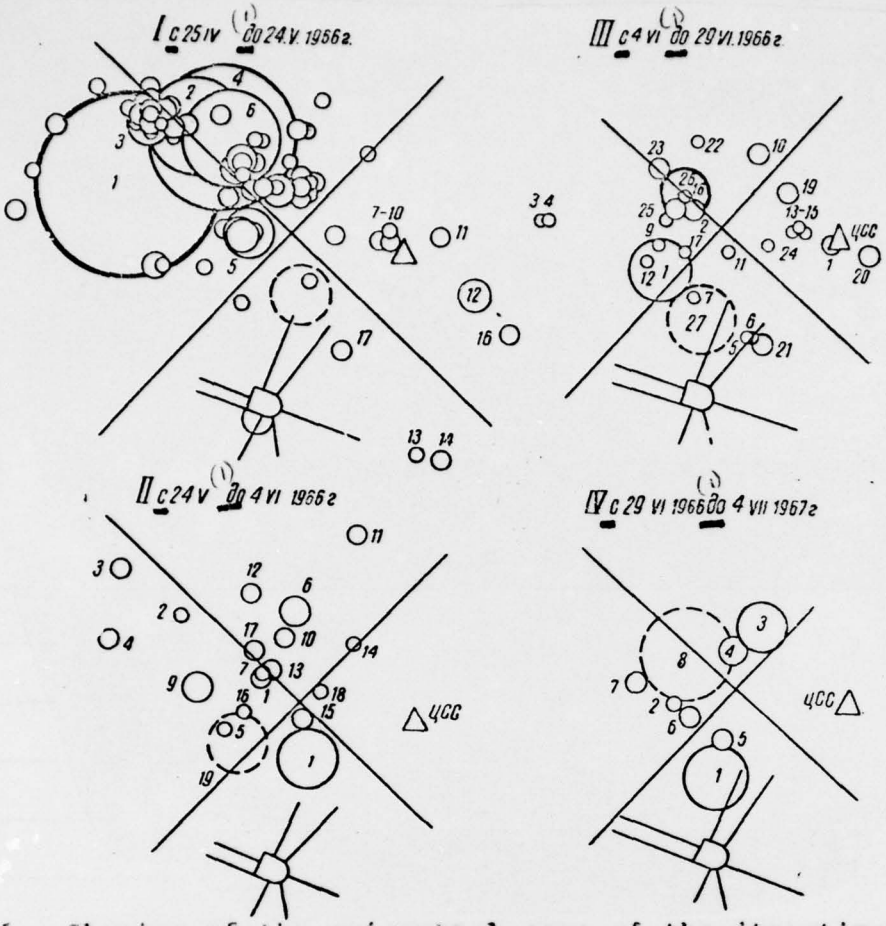
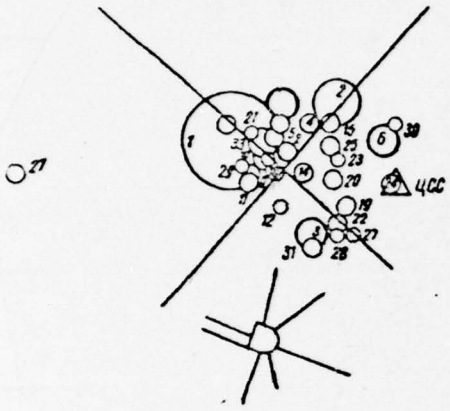


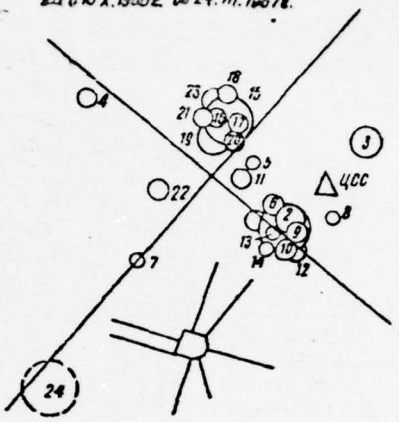
Fig. 66. Shaping of the epicentral zone of the iterative impulses of Tashkent earthquake. The size/dimensions of small circles are conditionally proportional to the energy classes K = lg E. 1 - the traces of cut/sections AB and C (Fig. 38); 2 - the garden of revolution; 3 - central seismic station "Tashkent" (I, II-VII - the stages of the migration of epicenters).

Key: (1) with to .

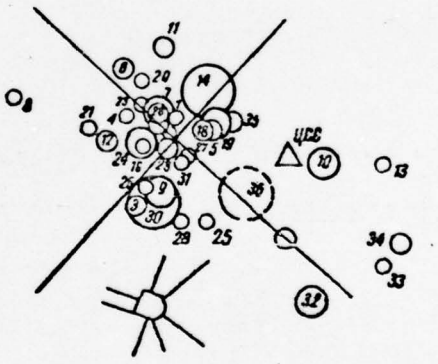
Vc 4 VII (1) до 18 VII. 1966 г.



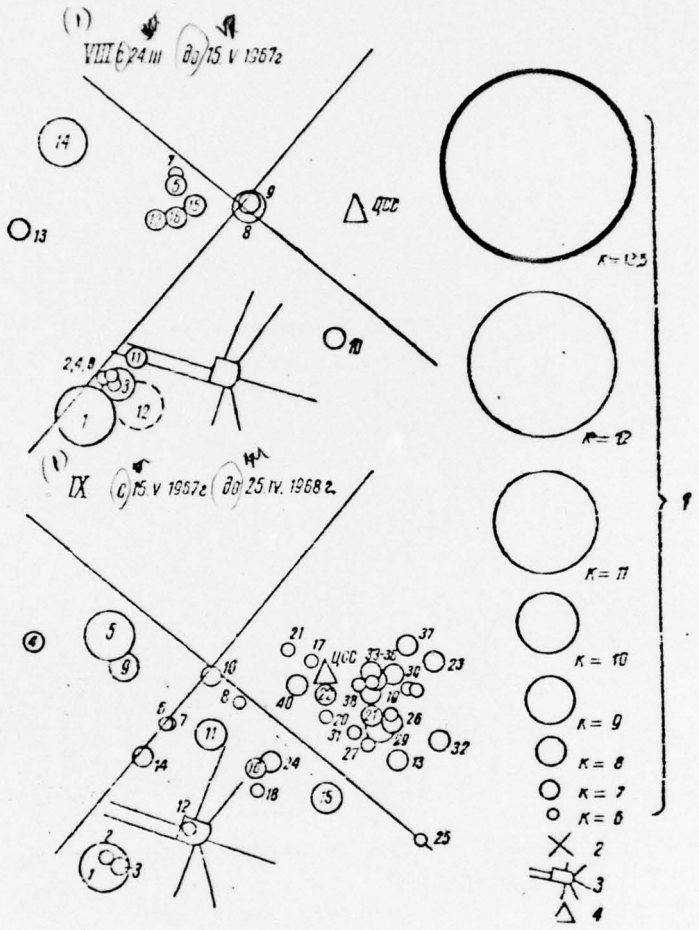
VII с 13 X. 1966 г. (1) до 24. III. 1967 г.



VI с 18 VII (1) до 13 X. 1966 г



Key: with to .


(1)
VIII б/24 III
д/15 V 1967г
ЦОС
К=13
К=12
(1)
IX
с/15 V 1967г
д/25 IV 1968г.
ЦОС
К=11
К=10
К=9
К=8
К=7
К=6
2
3
4

Key: with to .

Stages cover, in essence, time intervals between most powerful push (K = 10-11), beginning with preceding/previous and eliminating that which follow (figure shows by dotted line). Some stages are isolated conditionally (K = 9) in order somewhat to dress up figure. Within each stage the epicenters are energetically classified and numbered in sequence from No 1 to the fine number which corresponds to the "being design/projected" earthquake, i.e., No 1 following stage. By continuous numbering did not undergo only the first stage where a large quantity of epicenters of weak ($K \leq 9$) aftershocks is determined inaccurately due to the insufficient number of urban seismic stations. Here were labeled the only those aftershocks whose epicenters clearly jumped aside from the zone of their maximum density.

We examine each stage individually.

1. From 26. IV on 24. May 1966, right after the basic earthquake the numerous, noticeably damping on force aftershocks are concentrated predominantly on the northwestern outskirts of pleystoseystovoy zone, i.e., where the beginning is the vsparyvaniye of seismic joint. Here occurred the most powerful iterative impulses on 8 May into 03 hours 10 min. (K = 11) and two of following after each other aftershock on 10 May 00 hours 45 min. (K = 12) and on 10 May 00 hours 50 min. (K = 11) (time Tashkent). The predominant quantity of weaker aftershocks is observed in the epicentral zone of these earthquakes and their only insignificant number appears in the southeasterly part of the pleystoseystovoy region of the basic earthquake, along another side of GSS "Tashkent". It is possible that part of them is the forshokami of

the following jerk/impulse.

2. Powerful iterative impulse (K = 10-11) it occurred on 24 May 13 hours 50 min. in the center section of the pleystoseystovoy region. The series of weak aftershocks is arrange/located, in essence, to northwest from it. Here is design/projected the next powerful aftershock.

3. Iterative impulse is noted on 5 June into 03 hours 11 min. On force it is analogous preceding/previous (K = 10-11). The caused by it aftershocks to the first torque/moment appear to northwest from its epicenter, then sharply they are moved to southeast, and subsequently predominantly is filled northeastern section. Here occurs the jerk/impulse of the energy class K = 9.

4. The epicenter of the iterative impulse on 29 June 15 hours 00 min. (K = 10-11) is arranged several to the south all preceding/previous, in the center section of the pleystoseystovoy region of the basic earthquake (in the region of the garden of revolution). The secondary aftershocks proceed to north from it. Here is planned the epicenter of the next powerful underground jerk/impulse.

5. Epicenter of one of the strongest iterative impulses (K = 11) on 4 July 20 hours 22 min. is arranged in immediate proximity of the epicenters of the first three powerful aftershocks. This underground

jerk/impulse, apparently, is bygone by the beginning of the new cycle of the migration of the epicenters of aftershocks in southeasterly direction. The secondary aftershocks, as in the confirmation of the location of the doubtful epicenters of 1 stage, had extracted to scutheast from the epicenter of the basic aftershock. Most powerful of them with K = 9.

6-7. These stages are isolated conditionally for the discharge of the map/chart of epicenters. Apparently, a large quantity of aftershocks, which occurred during this period (5-7 stages), to a considerable degree it is caused by two by last/latter powerful repeated push (29. VI and 4 VII).

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however, even, here are noted some special feature/peculiarities. In this time interval, occurs the half of all jerk/impulses with K = 9. Is observed the oscillation of epicenters in scutheasterly direction (stage 6) and vice versa (stage 7). 8. On 24 March 1967 13 hours 04 min. is observed for the first time powerful aftershock (K = 10-11) whose epicenter is arrange/located on the left wing of discontinuity, less deformed at the torque/moment of the basic earthquake. The secondary iterative impulses appear first here, and then they migrate for the right wing of the main discontinuity where occurs the next jerk/impulse with K = 9. Almost all origin/hearths of aftershocks, arrange/located during left wing, have a mechanism, different from remaining iterative impulses, and, apparently, are caused by gradual

retraction into the motion of left wing in connection with the partial relaxation of the stresses in the right wing of discontinuity.

9. This last/latter stage is also conditional, since the process of iterative impulses Tashkent zmeletryaseniya yet completed. Stage begins from the next jerk/impulse (K = 9), which occurred 15. May 1967 during the left wing of discontinuity. Here we observe the repetition of the picture of the migration of aftershocks from left to the right wing discontinuity. As in the preceding case, the transition of epicenters from one wing to another occurs not gradually, but abruptly. The center section of the pleystoseystovoy zone in the form of the narrow band of northwestern strike/course as had not participated in discrete/digital stress relieving and is virtually deprived of epicenters.

Almost all epicenters of weak ($K \leq 8$) aftershocks 1968 are arranged during the right wing of discontinuity in its southeasterly termination and coincide with the section of the maximum uplift/rise of the surface of the Earth, reveal/detect/expposed by geodetic methods.

Oscillation of the origin/hearths of iterative impulses. We noted an oscillatory nature of the displacement/movement of the epicenters of aftershocks, i.e., their migration in direct/straight and opposite direction along pleystoseystovoy region.

The oscillation of epicenters can be observed, also, with the aid of the azimuth setting up of one seismic station (Fig. 67). Here along the axis of ordinates into both, sides from the axis of obstsiss are deposit/postponed the angles hearth by which azimuth setting up "sees" in horizontal plane the origin/hearths of aftershocks. The axis of abtsiss corresponds to the center line, directed into the central point of an entire epicentral zone, and simultaneously it is the scale of countdown. The role of azimuth setting up it fulfilled the assembly of seysmometrichesсy equipment for mechanical recording SMR, and also common type assembly synthetic rubbers with the orientation of the axes of horizontal pendulums along and across the center line.

In plan/layout the axis of abscissas coincides with the parallel of latitude, passing through the OSS of "Tashkent" and the center of epicentral zone. The location OSS in immediate proximity of pleystoseystovoy region and corresponding orientation of equipment gave possibility to almost error-free assort epicenters to the right or to the left relative to zero line and sufficient reliably (±5°) to calculate the absolute values of azimuths.

The period of the oscillation of the epicenters of aftershocks varied approximately from 1-3 months at first of protsesssa to 6-7 months toward the end of the first year after the main jerk/impulse. Emergence during March of 1967 origin/hearths of iterative impulses during the left wing of discontinuity sharply changed the monotonicity

of an increase in the cycle of oscillation. The period of the displacement/movement of epicenters was shortened to 2-3 months, and ther very considerably it increased.

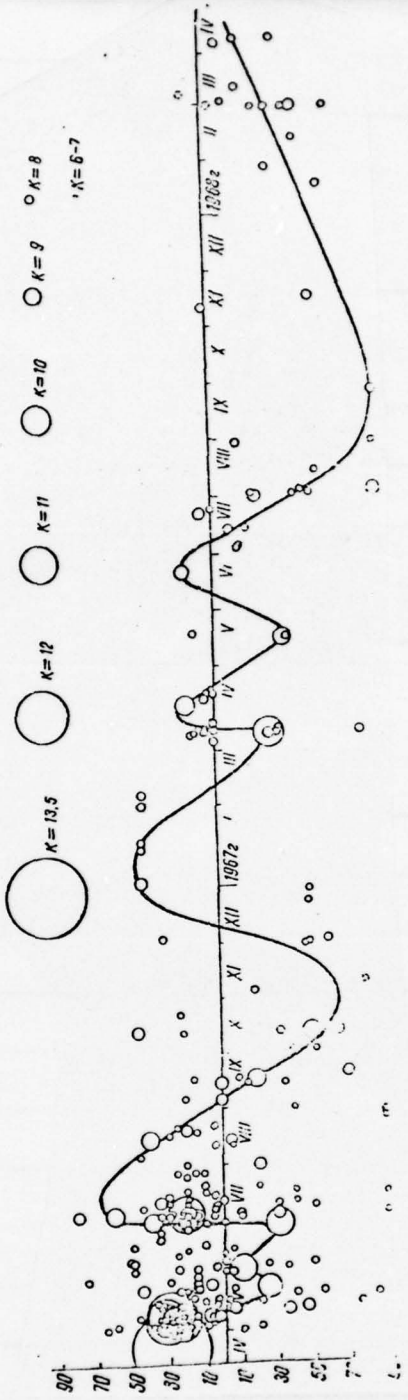

Fig. 67. Oscillation of the epicenters of the iterative impulses of Tashkent earthquake according to data of the azimuth setting up of QSS "Tashkent".

The phenomenon of the oscillation of epicenters one can see well on the space-time curve/graph of the seismic mode/conditions of aftershocks (Fig. 68). All most precise epicenters of iterative impulses are designed on the longitudinal (a) profile of southeasterly strike/course AB and orthogonal (b) northeastern strike/course SD [- sun sensor and are simultaneously developed with time (axis of ordinates). The extent of the longitudinal section of AV-7 the km, transverse SD-6 km (see Fig. 38). Most clearly the displacement/movements of epicenters are observed along the main discontinuity and across it.

The oscillation of the origin/hearths of aftershocks in depth it demonstrates Fig. 69. By examining both figures together, it is possible to reveal/detect/expose the full/total/complete space-time picture of the displacement/movement of the origin/hearths of iterative impulses.

At the torque/moment of the basic jerk/impulse on 26 April 1966 initial discontinuity of rock/species will arise at depth 8 km and it was extended to the side of topographic surface to depth 2-3 km. Immediately after earthquake almost entire this interval of depths begins to be filled with gipotsentrami very weak, hardly the perceptible aftershocks.

The displacement/movement of the origin/hearths of powerful aftershocks, beginning with 8. May 1966 (K = 10-11), within a month, occurs in direction to southeast and upward from depth h = 5-7 km of

up to h = 3-4 km (aftershock 24. May 1966 with (K = 10-11). Then for a while continues a decrease in the depth of the occurrence of origin/hearths and appears the tendency of motion in opposite direction (aftershock 5. June 1966 with K = 10-11 and h = 3 km). In plan/layout the displacement/movement occurs curved clockwise.

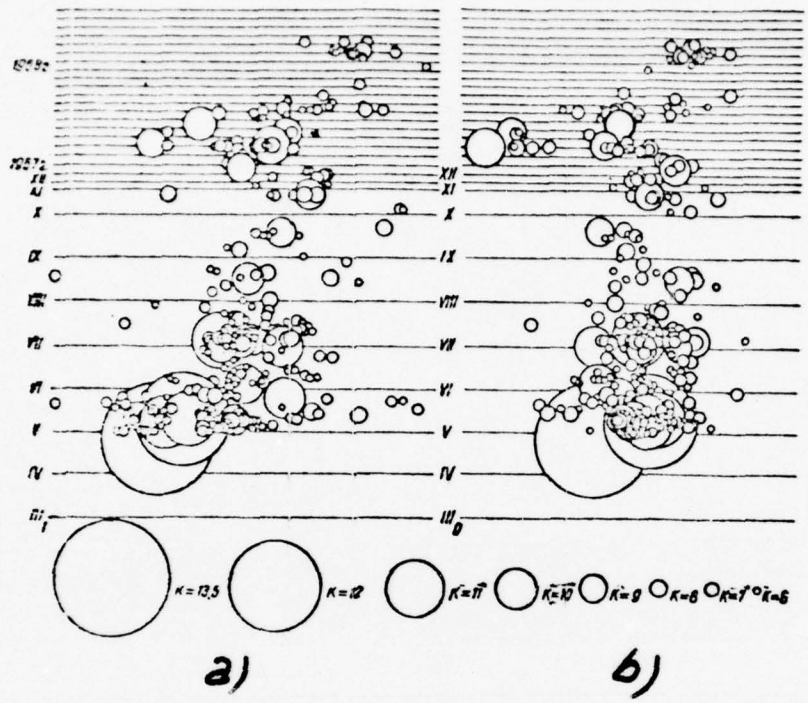

Fig. 68. The space-time curve/graphs of seismic mode/conditions (along the axis of ordinates deposit/postponed time t - months, in the upper part of the figure scale is compressed).

The Gipctsentr of next jerk/impulse 29. June 1966 (K = 10-11, h = 4 km) scnewhat will be sunk and it disrupts the displacement axis of the sequence of aftershocks. Fcllcwing, mcre pcwerful iterative impulse 4. July 1966 (K = 11, h = 3 km) seemingly it restored the previcus displacement axis and completes cycle, being arrange/located in plar/laycut near the epicenters of the first pcwerful aftershcccks. After this begins gradual, during 7-8 mcnths, the sinking of crigin/hearths repeated tolchkiv tc 6 km. During 3 months is retained the displacement axis of epicenters clcckwise, and frcm October this same year up tc until March 1967 displacement/mcvement of epicenters cccurs in oppcsite directicr.

With iterative impulse 24. Mar. 1967 (K = 10-11, h = 3-4 km) seemingly begun new almcst annual cycle. Relative to the sharply flcated gipotsentry again begin gradually tc be sunk to 6 km, and during February - March 1968 their depth again they become small, crder 3-4 km. After the appearance of crigin/hearths of aftershcccks during the left wing of discontinuity (24. Mar. 1967) in plan/laycut nc longer is cbserved the curved displacement/mcvement of the epicenters of iterative impulses. Frcm this pcint cn, occurred as if skirmish of the right and left wings of discontiruity. Ccmmunicatcn/connection cf seismic respcnse tc surface in epicentral region with the glubiniy cf the occurrence cf the gipotsentrcv cf aftershocks is well visible in Fig. 69. Almcst annual occurence of cycles is cbserved in the intensity of jclts.

Thus, the relaxation of the elastic strains in the

block/module/unit of the rocks of the focus region of Tashkent earthquake occurs not monotonically, but it is cyclic.

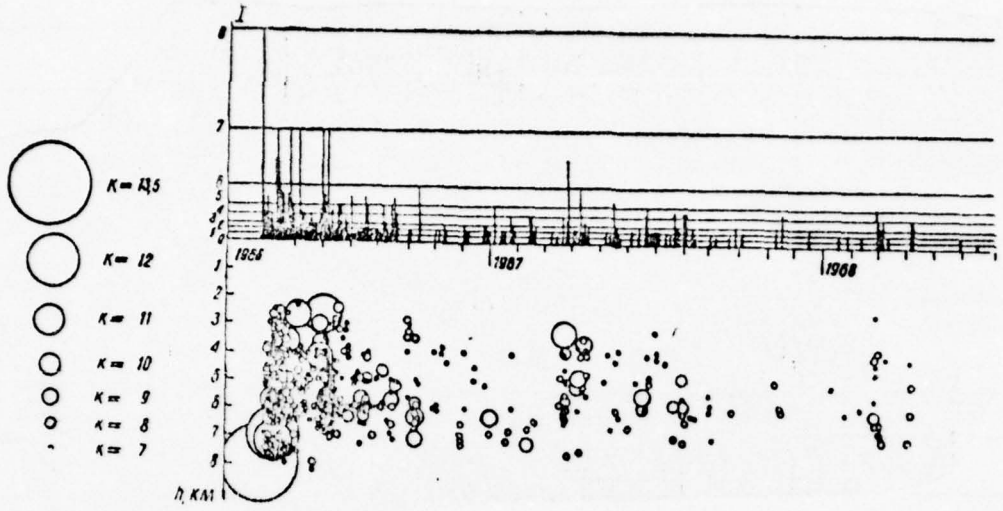

Fig. 69. The oscillation of the gipotsentrov of iterative impulses and seismic response to the surface of the Earth (I - the balls of jerk/impulses, h - the depth of the occurrence of their origin/hearths, the value of small circles are conditionally proportional to the energy classes K = lg E = 13, 12 ...).

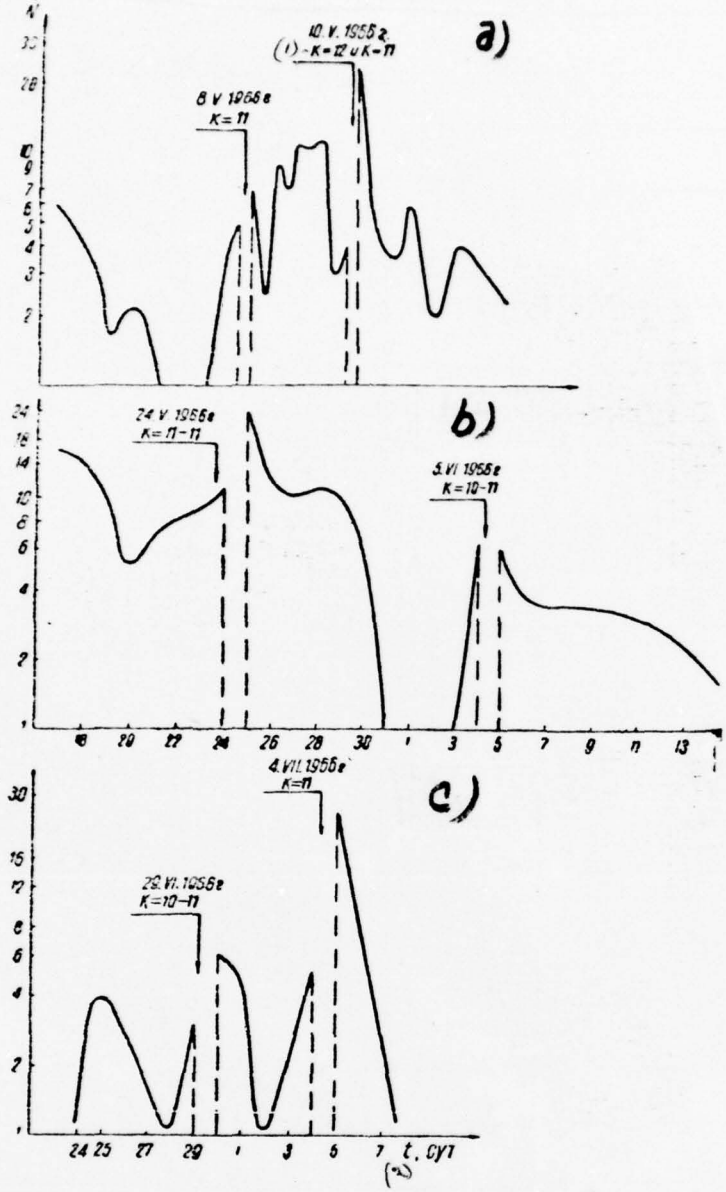

Fig. 76. Time distribution of a quantity of jerk/impulses in the period of the powerful (K = 10-11) aftershocks: a) iterative impulses 8 and on 10 May 1966 with the small interval of the time between them (1-2 days), the shch-hour sliding addition; b) the iterative impulses on 24 May and on 5 June 1966, the diurnal sliding addition; c) the iterative impulses on 29 June and on 4 July 196., the diurnal sliding addition.

Key: (1). K = 12 and K = 11. (2) t, day.

The straightening of the deformed rock/species had realized not in the form of translation, but as if way of the pokachivaniiz of side to the side, with the consecutive dropping of elastic strains from one place to the next, including in depth.

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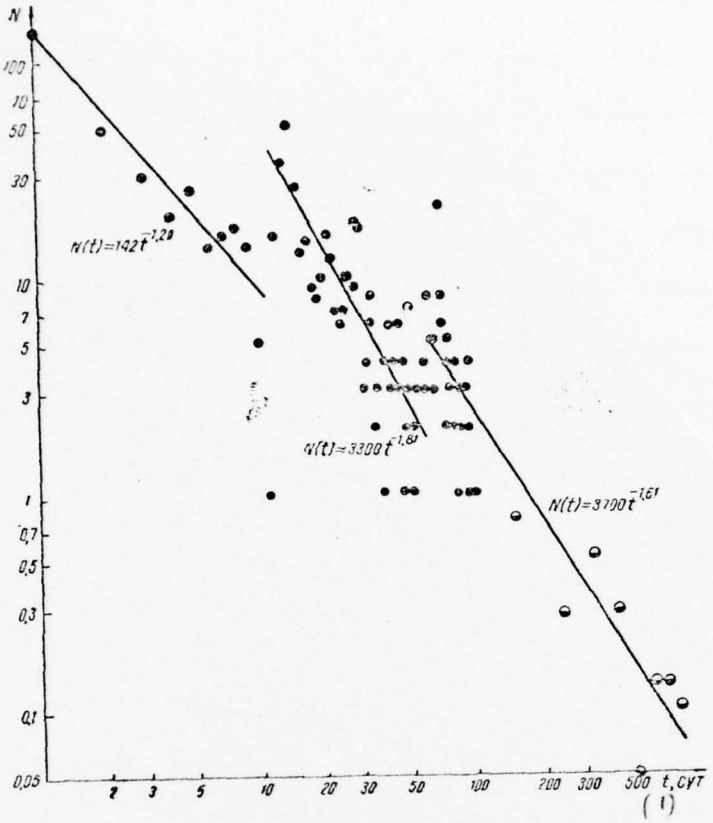

Fig. 71. Change in the quartity of iterative impulses N in time t (the crdinal number of days) after the basic earthquake.

Key: (1) t, day.

Forshoki, the secondary aftershocks and the cluster of iterative impulses. To Tashkent earthquake just as other powerful and strongest earthquakes, did not precede any noticeable underground jerk/impulses. At the same time even with insignificant in value iterative impulses (K = 9) were observed forshoki. This difference can be explained by the different nature of the discontinuity of the continuity of rocks. In the case of large earthquake, the discontinuity can have plasticheksiy a character, i.e., appear following the plastichesim current of rock masses in the region of origin/hearth and therefore not be anticipated by forshokami. It is possible that a similar process occurred before the Tashkent earthquake (Ulomov, Mavashev, 1967; Ulomov, 1968).

Forshoki can appear in the case of the brittle discontinuity which, apparently, occurs with iterative impulses. The same it is possible to say and about the clusters of earthquakes.

Research on the phenomenon of forshokov as forerunners of powerful iterative impulses has not only scientific, but also great practical value, since powerful aftershocks are capable to cause damage, sometimes not less than the basic earthquake.

Figure 70 depicts the curve/graphs of the distribution of the kolichesta of jerk/impulses per unit time before and after the most powerful aftershocks.

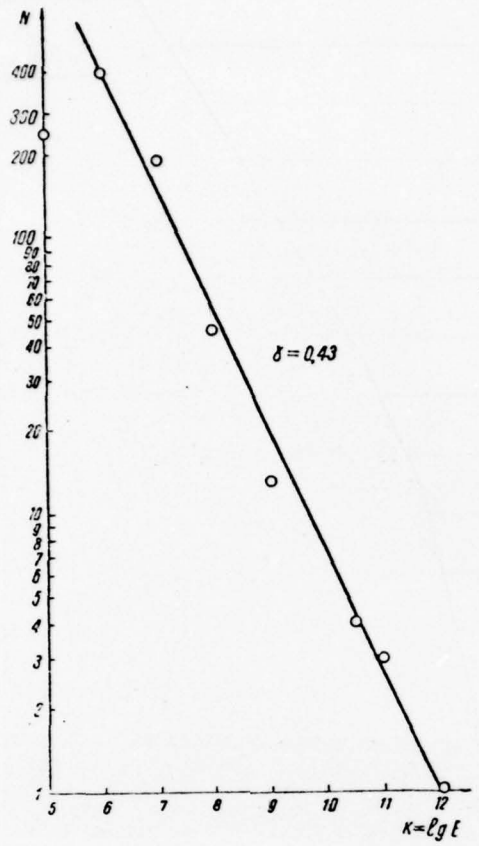

Fig. 72. Curve/graph of the frequency of the aftershocks of Tashkent earthquake. By small circles is shown the observed quantity N of the jerk/impulses of the determined energy class K = lg E, an angular coefficient $\gamma = -\Delta \lg N / \Delta \lg E$.

In this case, aftershocks themselves are not summarized. Addition produced on shch-hour intervals for the period of the increased activity and repetition frequency after each other of powerful aftershocks (a), also, on diurnal intervals - in relatively calmer period (b, c). The leveling of curve/graphs is realized by the sliding calculation with the respectively 2.5-hour and semidiurnal overlap of the indicated intervals along the axis of time.

The emergence of all powerful iterative impulses precedes the grow/rising series of forshocks, which appears after absolute or relative to pronounced calm. A quantity of the secondary aftershocks after powerful iterative impulse immediately grow/rises. The repetition frequency of the aftershocks of the second order decreases considerably faster than common/general/total fading an entire series of aftershocks.

Along with the grouping of forshocks and secondary aftershocks about powerful iterative impulses the Tashkentskoye of earthquake are observed the neobraznye groups of the jerk/impulses of approximately identical force (see Fig. 69). Usually these are jerk/impulses with K $\leqslant$ 8. The most characteristic cluster of aftershocks is noted 28-29 February 1968, when during one day it occurred 6 jerk/impulses at K = 6-8.

A Novoobraznoye increase in the frequency of the frequency of aftershocks is detected in the period of the increased seismic activity. So, in the interval/gap between powerful aftershocks 8 and

on 10 May (Fig. 70a) between two brief decreases in the activity, apparently, occurred the royechraznoye isolation of elastic energy. True, here can occur the superposition of the secondary aftershocks and forshokov. Is more demonstrative the royechraznaya group of the jerk/impulses, which occurred 25-27 June 1966 (Fig. 70b).

Research on the characteristics of the frequency of iterative impulses. Let us examine the simplest dependence: the distribution of a quantity of jerk/impulses with $K \geqslant 5$ in time consecutively according to days (Fig. 71). During the first 100 days (white small circles). In the latter case daily mean value fell on the middle of stosutochnogo time interval.

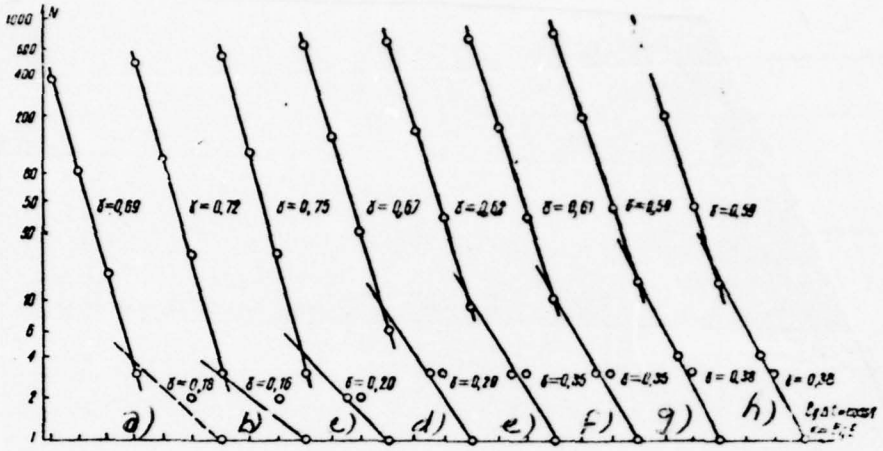

Fig. 73. Step by step curve/graphs of the frequency of iterative impulses. Time intervals a, b, c...h - are logarithmic equal and correspond 17.8; 32.0; 56.2...1000 days.

As can be seen from the obtained thus curve/graphs, as a whole dependence N = N (t) is almost rectilinear on dual logarithmic scale (lgN, lgt). At the same time comparatively clearly are separate/liberated three approximately logarithmic equal time intervals, for which the approximation of dependence N = N (t) can be another.

Immediately after the basic earthquake during the first 10 days is observed a monotonic decrease in the everyday quantity of iterative impulses according to the law $N(t) = 142t^{-1,20}$.

Will be worth focusing attention on two bounced downward points, which correspond to calm 5 and on 6 May. For which reasons suddenly did change the clear dependence of a quantity of jerk/impulses one and the same of value (K = 5-7)? The elastic energy of focus region seemingly concentrated in order following foreshocks to cause on 8 May the first of the most powerful aftershocks (K = 11). Then followed the strongest iterative impulses on 10 May (K = 12 and 11), sharply increased a quantity of aftershocks and noticeably changed the zaon of fading.

Up to earthquake on 29 June (K = 10-11) and on 4 July (K = 11) fading value N (t) it occurs considerably faster is described by the equation:

$$N(t) = 3300\,t^{-1,84}.$$

the iterative impulses on 24 May and on 5 June of the energy class K =

10-11 barely introduced distortions into the mode/conditions of fading. Then after aftershock on 29 June (K = 10-11) and especially on 4 July (K = 11) a daily mean quantity of jerk/impulses again increases, and the decrease of value N (t) somewhat decelerates, although it remains more than in the first interval:

$$N(t) = 3700\, t^{-1,61}.$$

In spite of these and other special feature/peculiarities of seismic mode/conditions, the distribution of entire quantity of jerk/impulses according to energy classes well it fits a straight line of the curve/graph of frequency with angular coefficient $\gamma = 0.43$ (Fig. 72). The value of coefficient γ coincides with the value of the analogous quantity, which characterizes seismicity.

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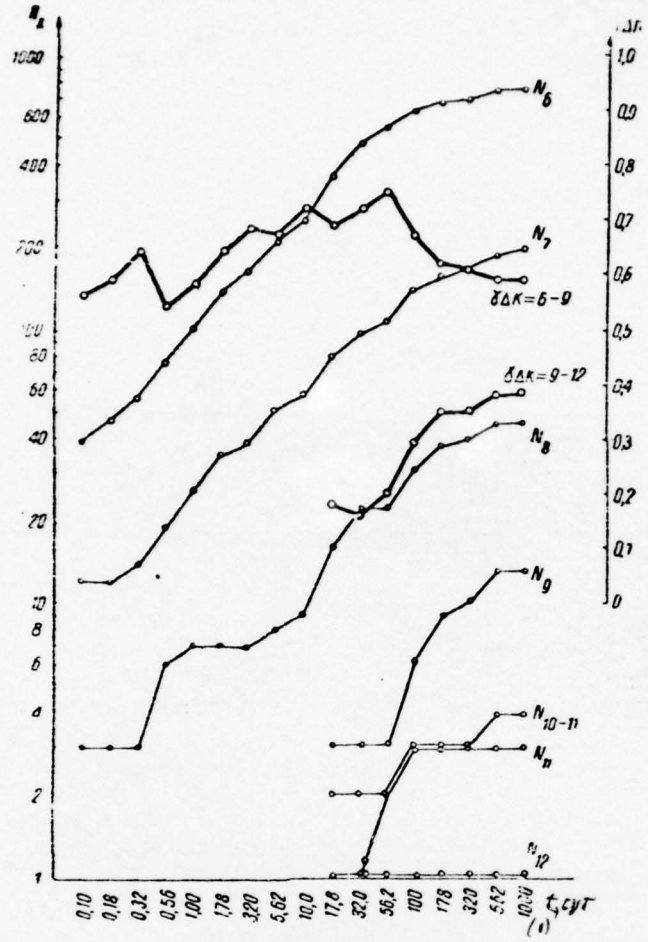

Fig. 74. Time dependence of parameters N (K) and $\gamma\Delta K$.

Key: (1) t, day.

Pritashkentskcgo region, and differs to the side of smaller values from the usual γ, characteristic for a series aftershocks of other earthquakes.

We did not succeed in with an accuracy to ±0.5 K relating at least one povtoryy jerk/impulse to the energy class K = 10; therefore we introduced one fractional class K = 10.5 (K = 10-11). In connection with this phenomenon, and also for the search for the ways of forecasting the missing before normal distribution powerful aftershocks in the process of iterative impulses were constructed the step by step curve/graphs of frequency. The duration of such stages corresponded logarithmic to different time intervals (Fig. 73), and each stage it included entire series of jerk/impulses from the torque/moment of the basic earthquake.

In this case, was explained the following special feature/peculiarity in the relationship of a quantity of jerk/impulses of different energy classes. On all without exception/elimination step by step curve/graphs (Fig. 73) the jerk/impulses, which correspond to the energy classes K = 6-9, almost ideally they approximated by the line segment with the constantly being changed angular coefficient. The intervals of the energy classes K = 9-12 are approximated by cut pyamcy nekol'ko worse, but are not placed in straight-line relationship N = N (K = 6-9).

Argular coefficient γ the second cut of the curve/graphs of frequency also is changed in time. With each stage the angle between two approximating cuts increased, the broken line seemingly straightens and it approaches in the limit of the direct/straight common curve/graph of frequency (see Fig. 73).

The more full/total/complete picture of change in time from the torque/moment of the basic earthquake of quartity N (K) of the tolchikov of different energy classes and value of angular coefficients $\gamma_{\Delta K}$ for $\Delta K = 6-9$ and $\Delta K = 9-12$ is shown in Fig. 74. With relatively monotonic increase in N (K) the curves $\gamma_{\Delta K}$ after two last/latter powerful aftershock on 29 June and on 4 July sharply change the direction of a change in its value and, converging, they approach $\gamma = 0.43$.

It is possible to assume that the reason for this phenomenon lies itself in different polkhode to the determination of the energy classes of weak and powerful bykh and powerful aftershocks it was conducted on one and the same nomogram T. G. Rautian, constructed for the stardard refereng-sphere of a radius 10 km. In this case, the calculation of the energy classes of powerful ($K > 10$) aftershocks was realized on the seismograms of the seismic stations, arrange/located outside this sphere ($\Delta > 50$ km), and weak jerk/impulses - on urban statiors inside or on refereng-sphere ($\Delta \leq 10$ km). In that and at other the cases the value of energy class was estimated, it is natural, in terms of the values of seismic energy on the surface of

referenq-sphere.

However, against this explanation of the reason for fracture, in the first place, speaks the fact of normal distribution according to the classes of entire quantity of iterative impulses of Tashkent earthquake (otherwise is bygone fracture and here), and also sufficiently clear correlation dependences between the classes, calculated simultaneously according to the rotations of the moved away and local exchanges.

Another attempt to explain the phenomenon of fracture and subsequent rectification of the curve/graphs of frequency can be based on the assumption of supplementary addition because of the appearance of aftershocks of the second order. However, if we judge by curve/graphs N (K) (Fig. 74), then it is possible to note that the powerful aftershocks, which cause the series of the secondary jerk/impulses, in practice do not affect the course of the increase of a quantity of weak aftershocks.

It is possible that the reason for this interesting phenomenon one should search for within focus region. Apparently, the same it is possible to say and about the energy discontinuity between two branches of the curve/graph of frequency, i.e., about the practical absence of aftershocks with $K = 10 \pm 0.5$, that, apparently, it is possible to explain by the special feature/peculiarities of the fragmentation of rock/species in the region of seismic center.

COMPARISON OF INSTRUMENT/TOCL AND MAKROSEYSMICHESKIKh DATA ON THE DEPTHS OF THE ORIGIN/HEARTHS OF ITERATIVE IMPULSES.

The systematic determination of the depth of origin/hearths, unfortunately it continues to remain the weak component/link of seismic service in many regions. This work it turned out to be possible to conduct for the exclusively powerful and prolonged series of the iterative impulses of Tashkent earthquake. Its results, besides systematic conclusion/derivations, can be useful also for research on the focus zone of this earthquake.

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Important circumstance is the fact that for the iterative impulses of Tashkert earthquake are sufficiently complete instrument/tocl data (obtained on three independent observation systems by the colleagues of the institute of seismology the A.S. of UzSSSR and VNNIGeofiziki) as well as makroseysmicheskiye data, collected by the colleagues of the institute of seismology the A.S. of UzSSSR. In the present work are used all these materials.

Estimation of the depth of origin/hearths. The initial data. For the period with 26 April 1966 through 17 October 1968 seismic stations of the institute of seismology recorded 1076 iterative impulses of the basic earthquake, 532 of them they were perceived in

city with force from 2 to 7 balls. More or less confidently the depth of the occurrence of gipotsentrov is determined for 462 iterative impulses (for 53 depth of origin/hearths is calculated by the colleagues of the institute of geology and geophysics, but for 28 are determinations from data of station "Earth").

From data of the stations of the institute of seismology, depth $h_{ис}$ the origin/hearths of iterative impulses was determined by the method of notches from hodograph S-P, calculated from high-speed/velocity cut/section in city distric for depths from 1 to 10 km. This cut/section is obtained as a result of seysmokartazha and recording powerful explosions by seismic stations. The error in determination of the depth of origin/hearth and its epicenter is 0.5-1 km. From data of the stations of the institute of geology the geophysicists the A.S. of the Uzb.SSR the depth of origin/hearths $h_{иг}$ was determined by analogous method; however, in this case was utilized another hodograph.

The depths of origin/hearths from data of station "Earth" were defined both by hand (method To Vadati or by the method of isochrones or known hodograph) and with the aid of EVM [- computer] with preliminary determination t_o and K from curve/graphs To Vadati (by method of izokhran with the abundant number of stations with simultaneous definition of three coordinates and speed). Subsequently used average value of these two depths, designated $h_з$.

The determination of the depth of origin/hearth completely from makroseysmicheskim data usually is conducted on the so-called makroseysmicheskoy formula (Shebalin, 1968) by radii or areas, izoseyst. However, in this manner it is possible to determine the depth of origin/hearth h_I only for jerk/impulse on 10 May 1966 (7 balls) and on 24 March 1967 (6-7 balls). It proved to be as according to instrument/tool data, equal to with respect 7 and 2-3 km.

For the mass determination of the depth of origin/hearths, makroseysmicheskiye materials on which were contained by the information about intensity in epicenter, were drawn instrument/tool data on the energy of jerk/impulses. The depth was determined from N. V. Shebalin's formula (1961, 1968), the connecting magnitudu M with intensity (intensity) in epicenter I_0 and the depth of seismic center h:

$$I_0 = bM - \nu \lg h_{MI_0} + c, \tag{54}$$

or, replacing for magnitudu M by energy class, according to transient formula T. G. Rautian (Riznichenko, 1960),

according to the formula in the central Asia conditions $K = 1.8M + 4,$ (55)

$$I_0 = b' K - \nu \lg h_{KI_0} + c',$$

where

$$b' = \frac{b}{1,8},\ c' = c - \frac{4}{1,8}. \tag{56}$$

Since the accuracy of the estimation of depth according to this formula depends on the accuracy of determination M (or K) and l_0, let us pause at the procedure for the determination of these values.

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Estimation of energy class. The energy class K was determined in the institute of seismology and the institute of geology the geophysicists. In the institute of seismology for this, was utilized standard procedure and standard calibration curve T. G. Rautian, observations of the OSS Tashkent, from which the origin/hearths were located at a distance from 0-3 to 7-8 km.

For a monitoring/checking with $K \geqslant 5$, were drawn the observations of the nearest regional station of "Sukok" ($\Delta \approx 50$ km), and with $K \geqslant 9$ - data and of the more moved away stations. The errors in determination of K could appear mainly because characteristic for the majority of the notations of iterative impulses single short-range ejection in wave $\bar{S}$ ("needle") not always it could be noticed by interpreter. Remaining amplitudes could be 2-4 times lower than the amplitude of "needle", and the appearing in this case error could, thus, reach 0.5-1.0 K.

Simultaneously was carried out determination K from data regional, and from the middle of June 1966 - the urban stations of the institute of geology and geophysics. Here for a small quantity of

jerk/impulses, determination K was based on the construction of the individual density curves of energy flow in the function of distance.

The comparison of all determinations $K_{игг}$ and $K_{ис}$ showed that after 20 June 1966, i.e., after the inclusion into working the urban stations of the institute of geology and geophysics, data on the average will agree well, but until 20 July $K_{игг}$ noticeably it exceeds $K_{ис}$, whereupon the disagreement the greater, the greater the depth of seismic center (for shallow jerk/impulses on the order of 0.5, for relatively sunk - 1). This disagreement is caused, apparently, by the systematic error of determination $K_{игг}$ purely systematic (if not technical) origin. This is confirmed during comparison $K_{игг}$ and $K_{ис}$ for 37 cases of most reliable determination $K_{игг}$ (Ye. M. Butovskoy's data).

From those which were indicated 37 cases for 21 determinations $K_{игг}$ was based on these regional stations of the institute of geology and geophysics. For this selection

$$K_{игг} - K_{ис} = 0{,}1^{+} - 0{,}1.$$

for 16 cases determination $K_{игг}$ was carried out to by data of urban stations. For this selection

$$K_{игг} - K_{ис} = -0{,}1 \pm 0{,}5.$$

for 53 cases:

$$K_{\text{итг}} - K_{\text{нс}} = 0{,}0 \pm 0{,}4.$$

Since the selection of reliable values $K_{\text{итг}}$ for entire totality of independent determinations $K_{\text{нс}}$ with a sufficient basis/base it can be considered random, we with large probability assume that the last/latter estimation is more acceptable for all determinations $K_{\text{нс}}$. The indicated circumstance in conjunction with the time-constant by determination $K_{\text{нс}}$ gives grounds during further working according to formula (58) to utilize precisely values $K_{\text{нс}}$.

Estimation of intensity in epicenter. The determination of the irtensity of the most powerful ($I_0 \geqslant VI$) jerk/impulses was carried out under the common/general/total management/manual of QSS "Tashkent" of the institute of seismology as a result of the examination/inspection of a series of routes in city, and also the detailed interrogation of population.

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For determining the intersity of weaker jerk/impulses (from 2 to 5-6 balls) was utilized, in essence, the information, obtained by central seismic station "Tashkent" from the inhabitarts of city from telephone. The instrument/tool recorded very weak jerk/impulses about which it did not come information from population, were considered imperceptible.

All information about intensity in the epicenter (J_0) of

iterative impulses, used in this work, is given due to data of the institute of seismology, this intensity is designated as $I_{опс}$.

With the accumulation of the material of observations in the institute of seismology in certain cases the intensity was estimated on the basis of mean statistical correlation between intensity and amplitude of the displacement of seismograph with the visible notation with thermal paper. These estimations of intensity were not utilized during the determination of the depth of origin/hearth from formula (54) or (56). In fact, amplitude measurement at certain average/mean hypocentral distance in practice is equivalent to determination of K, and mean statistical transition to I_0 means, in accordance with formula (56), the use of a mean statistical value of the depth of origin/hearth $h_{ср}$. With $h_{ист} > h_{ср}$ the true intensity, determined in amplitude, will be less accurate, with $h_{ист} < h_{ср}$ - more accurate. In the latter case most frequently will follow telephone bells from city, and the observed in city value of intersity will be established/installed. Thus, the intensity, evaluated in the amplitude of seismograph with the visible notation, can be either close to the one who was observing in city or that which was overstated, and the use of such conditional "intensities" will lead to the systematic overstatement of the depths of jerk/impulses. This circumstance determined the specific character by that used in this case of the procedure for consistent data processing makroseysmicheskikh and instrument/tool data, different from the standard procedure, described in the work of Shebalina (1968).

Refirement of the local dependence between class, intensity in epicenter and the depth of origin/hearth. The results of the determination of the depth of origin/hearth with application/use in formulas (54) and (56) average values $\beta=1.5$, $\nu=3.5$ and $c = 3.0$ satisfactorily agree with instrument/tool definitions; however, desirably the refinement of these coefficients for a Pritashkentskogo region.

This refinement is already executed on the material of basic and nine iterative impulses with most reliably determined values I_0, M and h:

$$I_0 = 1{,}45\ M - 2{,}7 \lg h + 2{,}8. \qquad (57)$$

during the application/use of this equation in the treatment of entire totality of iterative impulses the value of the coefficient with M ($\beta = 1.45$) does not cause doubts, since it is determined by independent data within the limits of city. However, the value of the coefficient with lgh ($\nu = 2.7$) must be verified, since it is bygone determined by the decrease of intensity on distant izoseystakh, beyond the limits of urban territory. Specifically, it is possible to assume that for relatively deeper and finer iterative impulses the absorption, and therefore ν can be different.

D14, the checkings are determined the values of coefficients of ν

and c' in equation (56) for two groups of the earthquakes: (h = 5-8 km, I_0 = 6 1/2-8 and I_0 = 2 1/2-3) and (h = 2-4 km; I_0 = 6 1/2-8 and I_0 = 2 1/2-3). The selection only of determined groups of intensity will be clear from the following.

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The coefficient with K was taken as 0.8 (b' = b/1.8, with b = 1.45). Results of the definition: for the first group (deeper jerk/impulses) ν = 3.1, c' = 0, for the first and second groups: ν = 2.5, c' = 0.5.

Thus, the addition of fine origin/hearths not only does not increase the averaged absorption coefficient, but even it decreases it, possibly, because with fine origin/hearths to ray/beams it is not necessary to pass entire crushed focus zone. Taking into account errors the value of coefficient ν = 2.7 proves to be to acceptable, also, for nearest to origin/hearth zone, the depth of origin/hearth in the first approximation, can be determined by formula (57) or by the equivalent to it formula:

$$I_0 = 0{,}8\ K - 2{,}7 \lg h_{KI_0} - 0{,}4. \qquad (58)$$

Determination h'_{KI_0} (first approximation). The values of depth $\left(h'_{KI_0}\right)$ the origin/hearths of iterative impulses, calculated by formula (58), are only first approximation in connection with the fact that the greatest complications during determination h_{KI_0} are

connected with the possible considerable errors during the establishment of intensity. However, in the first approximation, data $h_{нс}$, $h_{нгг}$, $h_з$ as a whole will agree well between themselves. For the cases of the simultaneous determination of depth two methods obtained the following average estimations:

$$h_з - h_{нс} = -0{,}8\ км \pm 1{,}4\ km \text{ (19 cases);} \tag{59}$$

$$h_{нгг} - h_{нс} = -1{,}6\ км \pm 1{,}8\ km \text{ (48 cases);} \tag{60}$$

$$h_{KI_0} - h_{нс} = +0{,}5\ км \pm 3{,}2\ km \text{ (II-VIII balls, 173 cases);} \tag{61}$$

$$h_{KI_0} - h_{нс} = -1{,}0\ км \pm 2{,}0\ km \text{ (III-VIII balls, 129 cases).} \tag{62}$$

Here and subsequently during all comparisons of depths are used data of the institute of seismology, obtained from three and more statiors.

Thus, when using maksorsysmicheskikh data considerably increases the number of definitions, and accuracy in this case is obtained only somewhat lower than with most reliable instrument/tool data. Important circumstance is also lightness/ease and the simplicity of the method: one determination of the depth of origin/hearth from formula (58) occupies a total of several seconds (when using a nomogram).

Disagreements in the determination of the depth of origin/hearth. Investigate the now obtained from formula (58) values of the depth of origin/hearths in more detail, keeping in mind the possible errors mentioned above in the determination of intersity.

Depending on the depth of origin/hearth with an error in 1/2 balls, the error in the determination of depth can comprise from ±1 km (with h = 2 + 3 km) to ±3 km (with h = 7 + 10 km) (Table 14). For the group of earthquakes with an intensity of 6 1/2-8 balls of the value of depth, determine by two methods, on the average coincided with high accuracy. This is logical, since the precisely this group of jerk/impulses is used for determining coefficients in formula (58). Thus, in the first table row there is nothing new. Other groups of jerk/impulses detect the noticeable systematic deviations, which emerge beyond the framework of random errors. The average values of these deviations are given in graph/court δh_1.

The given comparison of the energy classes, determined in different observation systems, shows that the errors in determination K hardly can be the source of significant systematic errors.

Table 14. Comparison of the depth of the origin/hearths of iterative impulses, determined according to formula (58), with the depth, obtained from instrument/tool observations in the institute of seismology.

(1) I_0, балл	$\Delta h_i = h_K/I_0 - h_{ис}$, км										
	−5	−4	−3	−2	−1	0	1	2	3	4	5
6,5—8					4	2	2	1			
5,5—6		3	4	0	2	1	0	1			
4,5—5	2	6	8	6	4						
3,5—4		1	6	9	4	6	1				
3			1	7	10	17	11	3	3	3	0
2					1	0	3	11	4	6	9
(2) Все толчки	2	10	19	22	25	26	17	16	7	9	9
(3) Доля общего числа толчков	0,01	0,06	0,11	0,13	0,14	0,15	0,10	0,09	0,04	0,05	0,05
(4) Накопленная доля	0,01	0,07	0,18	0,31	0,45	0,60	0,70	0,79	0,83	0,88	0,43
(5) Все толчки 3—8 бал.	2	10	19	22	24	26	14	5	3	3	0
(6) Для общего числа толчков	0,02	0,08	0,15	0,17	0,18	0,20	0,11	0,04	0,02	0,02	0
(7) Накопленная доля	0,02	0,10	0,25	0,42	0,60	0,80	0,91	0,95	0,97	0,99	0

(1) I_0, балл	$\Delta h_i = h_K/I_0 - h_{ис}$, км							$\overline{\Delta h_i}$	h	σ_h
	6	7	8	9	10	11	>12			
6,5—8								0,0	9	1,0
5,5—6								−2,2	11	1,8
4,5—5								−2,8	26	1,3
3,5—4								−1,6	27	1,3
3	1							0,1	56	1,8
2	2	2	1	2	0	0	4	+4,6	45	3,1
(2) Все точки	3	2	1	2	0	0	4	+0,5	174	3,2
(3) Доля общего числа толчков	0,02	0,01	0,01	0,01	0	0	0,02			
(4) Накопленная доля	0,95	0,96	0,97	0,98	0,98	0,98	1,00			
(5) Все толчки 3—8 бал.	1							−1,0	129	2,0
(6) Для общего числа толчков	0,01									
(7) Накопленная доля	1,00									

Key: (1). I_0, ball. (2). All jerk/impulses. (3). Fraction of the total number of jerk/impulses. (4). Accumulated portion/fraction. (5). All jerk/impulses 3-8 ball. (6). For the total number of jerk/impulses. (7). Accumulated portion/fraction.

Besides to toga K_{nc} always it was determined at virtually constant epicentral distances, but that is why error in determination K could not systematically change with an increase J_0 (but, which means, on the average, and K). Nevertheless, is verified, how energy a classes are the reason for the nonccincidence of values h_{KI_0} and $h_{нс}$.

In accordance with the given estimations of the standard deviation of differences in the depths, сределенных several methods, let us consider agreement the cases when $|\delta h_1| = |h_{KI_0} - h_{нс}| \leqslant 2$ km, and by nonccincidence - all the remaining cases. In Fig. 75 upper hystogram shows number distribution of noncoincidences to the percentage of all cases for this K (n/N). It is easy to see that with the full/total/complete independence of the studied value from K the lower hystogram must be straight line with ordinate 1. In our case the percentage of noncoincidences is close to 1 for all classes and only insignificantly grow/rises for K in the interval from 7 to 7.9.

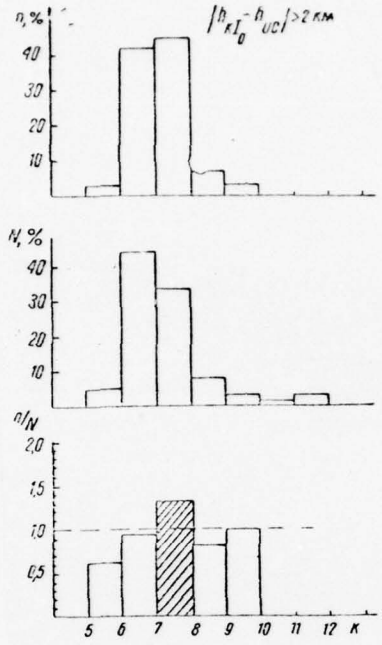


Fig. 75. Checking the reponsibility of the determination of energy class for the noncoincidence of determinaticrs h_{KI_0} and $h_{нс}$ (upper hystcgram - distribution according tc K cf the cases of rcrccincidence h_{KI_0} and $h_{нс}$; average is distribution according tc K cf all cases of consistent determinaticn h_{KI_0} and $h_{нс}$; lower is relaticn cf distributions).

Thus, is reveal/detected the sufficiently weak dependence of the noncoincidence of depths on the errors in determination of class in the indicated interval.

To jerk/impulses with this value of K, however, corresponds on the average the intensity of 3 balls, most satisfactory in the sense of the agreement of depths. Consequently, significant deviations during calculations of the depth of origin/hearth cannot be explained by errors in determination.

Let us examine systematic disagreement in the determinatior of depth by tool house and composite by makroseysmicheskimi methods. For this, let us take first of all the disagreement between the determinations of depth from formula (58) and the instrument/tool determinations of the institute of geology and geophysics (Table 15).

In Fig. to 76 on data of Table 14 and 15 are plotted the values of differences $h_{KI_0} - h_{нс}$ and $h_{KI_0} - h_{нгг}$, which, coinciding for group 6 1/2-8 balls, at the smaller values of intersity diverge approximately to 2-3 km. If on the average are accurate values $h_{нгг}$, then the depths of origin/hearths, determined on I_0 and K, are accurate for 2 1/2-8 balls and are strongly exaggerated for 2-3 balls; but if on the average are accurate values $h_{нс}$, then the depths of origin/hearths are accurate for group 3 and 6 1/2-8 balls, are exaggerated for 2 and are underestimated for 4-6 balls.

At first glance, the first of the hypotheses seems more accurate,

since the depths of origin/hearths h_{KI_0} and $h_{игг}$ coincide for the larger interval of intersity. More detailed analysis shows however, that this is erroneous, and that of two values of instrument/tool depths on the average accurate proves to be depth $h_{ис}$; agreement h_{KI_0} and $h_{игг}$ in the large interval of intensity proves to be the result of the superposition of errors.

For the proof of the validity of values $h_{ис}$, let us examine first of all the behavior of difference $h_{игг} - h_{ис}$. Average difference $h_{игг} - h_{ис}$, obviously, can be obtained in two ways. From Table 15 it follows that

$$h_{KI_0} - h_{игг} = 2{,}0 \text{ km} \tag{63}$$

by deducting formula (63) from (61) we will obtain

$$h_{игг} - h_{ис} = -1{,}5 \text{ km}.$$

Table 15. Comparison of the depth of iterative impulses, determined according to formula (58), with the depth, obtained from instrument/tool observations in the institute of geology and geophysics.

(1) I_0, балл.	$\delta h_2 = h_{KI_0} - h_{ИГГ}$, км															$\overline{\delta h_2}$	n	$\sigma_{\delta h}$
	−3	−2	−1	0	1	2	3	4	5	6	7	8	9	10	17			
6,5—8		2	3	1	0	1	1									−0,25	8	1,8
5,5—6		1	0	2												−0,7	3	
4,5—5			4	1	1	1										−0,1	7	1,2
3,5—4	1	1	1	1	0	3	1	1								0,8	9	2,4
3			1	1	3	5	2	1	2	2	1	0	0	1		3,2	19	2,7
2							2	2	1	6	0	0	1	0	1	6,4	7	5,1
(2) Все толчки	1	4	9	6	4	10	6	4	3	2	1	0	1	1	1	2,0	53	3,5
(3) Все толчки 3—8	1	4	9	6	4	10	4	2	2	2	1	0	0	1		1,4	46	2,7

Key: (1). I_0, ball. (2). All jerk/impulses. (3). All jerk/impulses 3-8.

Another selection (case of simultaneous obtaining values $h_{изг}$ and $h_{нс}$) it corresponds to dependence (60).

$$h_{изг} - h_{нс} = -1{,}6 \text{ км}$$

The behavior of difference depending on intensity is represented in Fig. 77.

During the investigation of the factors, which caused noncoincidence $h_{изг}$ and $h_{нс}$, established/installed following: a) the error in the determination of intensity can be the reason for noncoincidence $h_{изг}$ and $h_{нс}$ only to a slight degree, noncoincidence increases for 5 and in less measure for 3 and 4 balls;

b) statistician on to classes insufficiently is assured: is reveal/detected only weak otnetstvenost' for the noncoincidences of classes in interval of K = 8-9.9;

c) the error in the determination of the depth of origin/hearth is the reason for the noncoincidence of the values of depths (Fig. 78): the majority of noncoincidences $h_{изг}$ and $h_{нс}$ is related to the cases when $h_{нс} = 5\text{-}7$ km. If we relate distribution to value $h_{изг}$, then the majority of noncoincidences $h_{изг}$ and $h_{нс}$ is related to cases $h_{изг} = 1.5\text{-}3$ km.

Thus, the systematic error in the determination of depths, which is expressed in the fact that for the large group of jerk/impulses IGG is obtained depth on the order of 1.5-3 km, and IS - order 5-7 km

undoubtedly can be the reason for the noncoincidences of the depths of the origin/hearths, determined purely instrument/tool, also, according to formula (58).

Attempt to utilize as the checking of value $h_з$ does not give the determined result: determinations $h_з$ are scarce, two employed here methods frequently give the strongly being distinguished values of depth; it is possible to only indicate, that on the average for 19 cases

$$h_{EI_0} - h_з = 1{,}0 \pm 1{,}4 \qquad (64)$$

and that from the comparison of dependences (64), (63), (61) and (62) it follows that estimations $h_з$ lie/rest on the average between determinations $h_{\text{нст}}$ and $h_{\text{нс}}$. Of 13 cases of consistent determination $h_{\text{нс}}$ and $h_з$ for disputable/debatable depths ($h_{\text{нс}} =$ 6-7 km values $h_{\text{нс}}$ and $h_з$ coincide in 8 cases and do not coincide into 5.

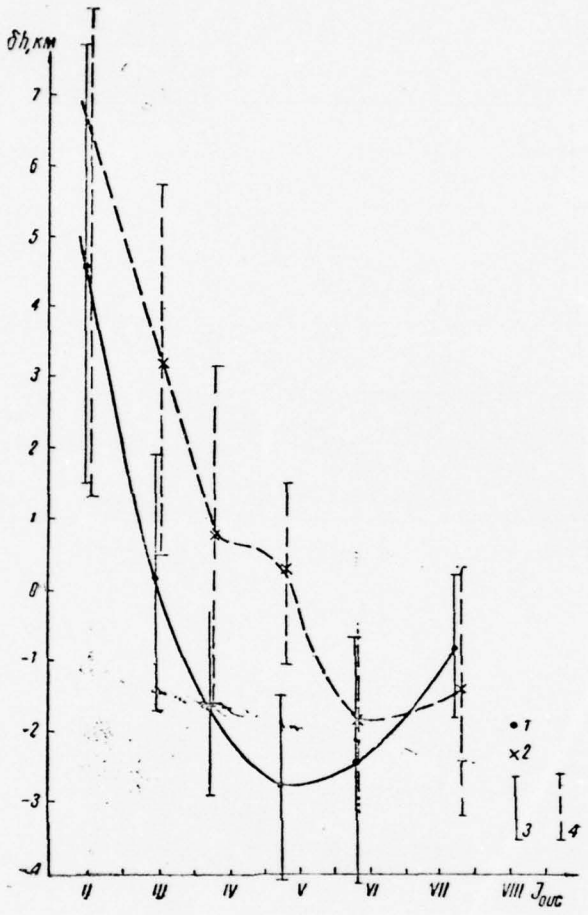


Fig. 76. Comparison of the dependence of differences $h_{KI_0}-h_{ис}$ and $h_{KI_0}-h_{ист}$ on intensity in epicenter $I_{оис}$: 1 - $\delta h_1=h_{KI_0}-h_{ис}$; 2 - $\delta h_2=h_{KI_0}-h_{ист}$. The standard deviations: 3. for δh_1; 4 - for δh_2.

Investigate the cases of noncoincidence h_{KI_0} and $h_{нс}$ on $h_{нс}$ and the cases of noncoincidence h_{KI_0} and $h_{нгг}$ on $h_{нгг}$ (Fig. 79). The depth of origin/hearth $h_{нс}$ is not the reason for the disagreement of values h_{KI_0} and $h_{нс}$ and, on the contrary, precisely the depth of origin/hearth $h_{нгг} = 1.5-2$ km it is the basic reason for noncoincidence $h_{нгг}$ and h_{KI_0}. Hence it follows that in the brightest group of the disagreements of purely instrument/tool determinations $(h_{нс} \approx 6-7\ км,\ h_{нгг} \approx 2\ км)$ accurate turn out to be values $h_{нс}$. Investigation the reasons for the disagreements of the instrument/tool determinations of depth exceed the scope of this section.

Thus, remains the sole reason for noncoincidences h_{KI_0} and $h_{нс}$, namely - the errors in the estimation of intersity in epicenter, most significant for 2 and 4-5 balls and differing for these groups in sign (see Fig. 76).

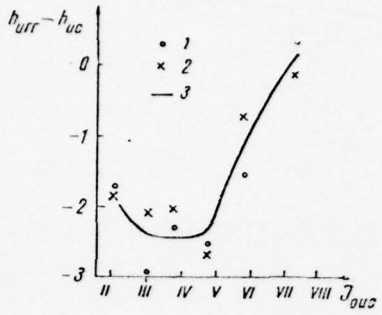
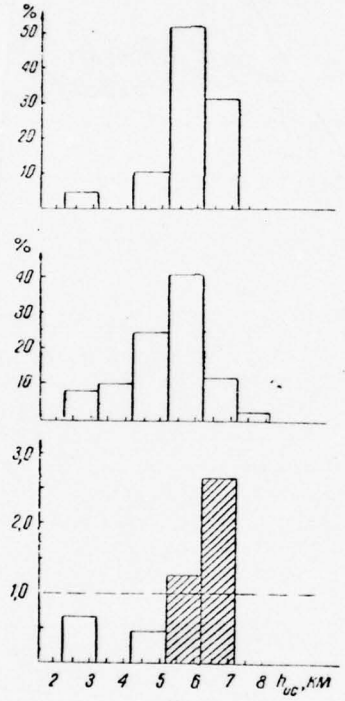


Fig. 77. Dependence of difference $h_{игг}-h_{ис}$ on intensity in epicenter $I_{оис}$. 1 - $h_{игг}-h_{ис}=\overline{h_{KI_0}-h_{ис}}-\overline{h_{KI_0}-h_{игг}}$; 2 - values $h_{игг}-h_{ис}$, obtained by averaging for the cases of the simultaneous determination of these values; 3 - the averaging curve.

Fig. 76. Checking the reponsibility of the determination of the depth of origin/hearth $h_{ис}$ for the roncciridence of determinations $h_{игг}$ and $h_{ис}$ (upper hystogram - distribution according to K of roncoincidences $h_{игг}$ and $h_{ис}$; average is distribution according to K of all cases of consistent determination $h_{игг}$ and $h_{ис}$; lower is relation of distributions).



The specificity of error for 2 balls is noticeable according to other data. Selective average of this group and in remaining groups differ more than for the sum of standard deviations. Furthermore, the addition of group with the intersity of 2 balls sharply increases the deviation of number distribution of cases according to values $h_{KI_0} - h_{ис}$ from noraml'nogo law (see Table 14).

Calculation of corrections to intersity. From formula (58) it follows that the overstatement of depth h_{KI_0} in constant/invariable K corresponds to understating I_0. Consequently, the reference of the very large number of jerk/impulses, which were being perceived by a few people, to 2 balls could be erroneous. The systematic error of the estimation of intensity in epicenter can be determined by the expression:

$$\delta I = I_0 - 0{,}8\ K + 2{,}7\ \lg h + 0{,}4, \qquad (65)$$

if we as the true value of depth utilize known values $h_{ис}$. During calculation for 45 cases of 2-scale-number jerk/impulses with known depth we obtain:

$$\delta I_{II} = +0{,}64 \pm 0{,}06,$$

during the standard deviation of single estimation $\delta = \pm 0.4$. It is interesting that the obtained correction only to a slight degree depends on the time of the days: for the period of days $1-8^h$ GMT (7-14 hours of local time, i.e., time greatest to aktivnoti population, 8 cases) $\delta I_{II} = +0{,}89 \pm 0{,}14$, for other two eight hour

periods (9-17 and 20 and 17 cases) corrections are equal to with respect 0.64 ± 0.09 and 0.54 ± 0.10 during the same standard deviation of single estimation.

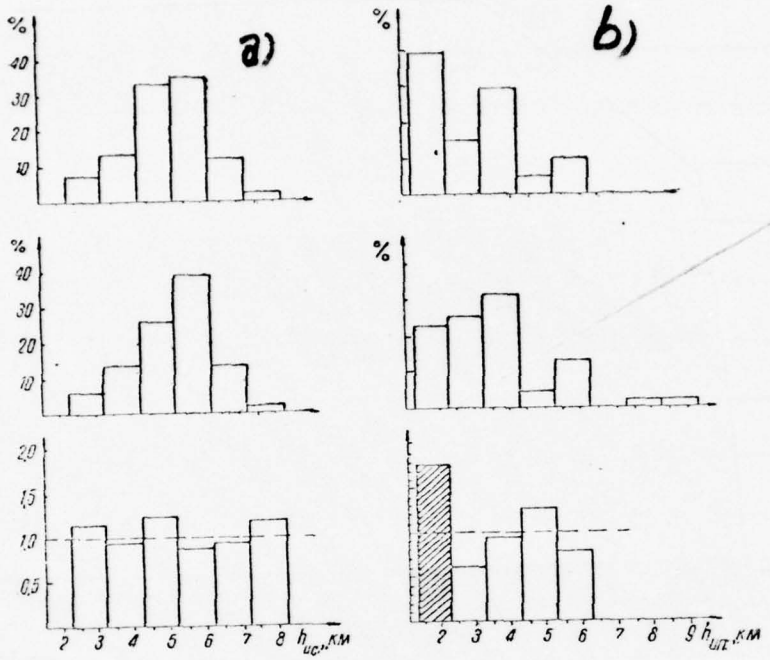


Fig. 79. Checking the reponsibility of the determination of the depth of origin/hearth $h_{ис}$ for the nonccincidence of determinations h_{KI_3} and $h_{ис}$ (a) (upper hystogram - distribution according to h of nonccincidences, average is distribution acccrding to h of all cases of the consistent determination of depth, lower is relation of distributions).

Thus, the average limit of the oshchushchaemosti of earthquakes I_{min} in large city with relatively interse right life and, it goes without saying, with the aggravated sensitivity of inhabitants it fluctuated between 2 1/2 and 3 balls, whereupon in night time it rose on the average in all by 1/4 balls.

Is considerably more noticeable a variation in the average limit of the oshchushchaemosti of earthquakes during entire period of the iterative impulses:

$$I_{min} = 2 + \delta I_{II}.$$

For the calculation of changes I_{min} in time was computed current average value δI_{II} on the sliding intervals of the averaging into of ten individual values δI_{II}. This value was related to the middle of the interval between the first and tenth push. As a result established/installed (Fig. 80) that to period the most heavily transferred by inhabitants "-scale-number jerk/impulses in May-June 1966 limit was omitted, i.e., the sensitivity of inhabitants grew/rose. During July began relative damping and peculiar adaptation, interest in weak jerk/impulses it fell and the threshold of oshchushchaemosti it increased. As jerk/impulses became ever more rare phenomenon, to them again they began to be related more attentive, and the threshold of oshchushchaemosti again was lowered, after accepting stable value of approximately 2 1/2 balls. It is possible to think that the investigation of a variation in the sensitivity of population to weak jerk/impulses they are of definite interest from the medical point of view.

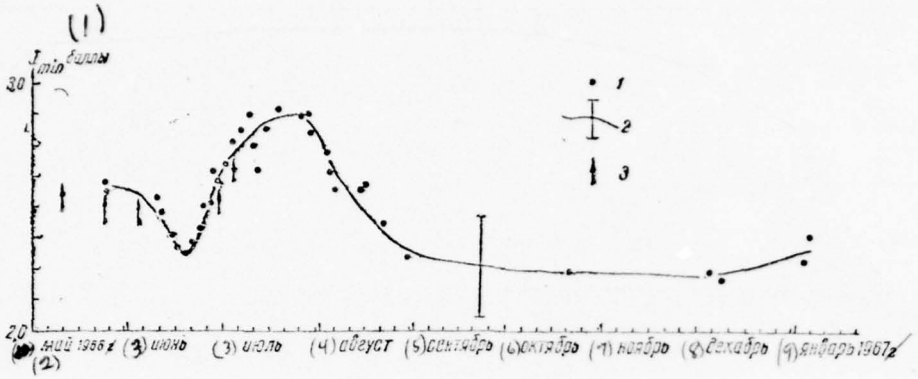


Fig. 8C. Change in the limit of the oshchushchaemosti of weak jerk/impulses in the course of time. 1 - the current average (of ten values) limit of the oshchushchaemosti of earthquakes, referred to the middle of the interval between the first and tenth push; 2 - the averaging curve and the 90c/c confidence interval of determination; 3 - the torque/moments of "-scale-number jerk/impulses.

Key: (1). balls. (2) May. (3) July. (4) August. (5) sektyabr'. (6) October. (7) November. (8) dekabr'. (9) January.

For the group of III-scale-number jerk/impulses correction, as one would expect, it turned out to be completely insignificant:

$$\delta I_{III} = 0{,}09 \pm 0{,}05.$$

The corrections, calculated for jerk/impulses from 3 1/2 to 6 balls, they showed that the intensity of these earthquakes systematically was overstated, whereupon it is sufficiently considerable (from 1/2 to 1 ball):

$$\delta I_{IV} = -0{,}56 \pm 0{,}08 \quad \text{(27 cases)};$$

$$\delta I_{V} = -1{,}09 \pm 0{,}09 \quad \text{(26 cases)};$$

$$\delta I_{VI} = -0{,}88 \pm 0{,}19 \quad \text{(11 cases)}.$$

It goes without saying that to restore/reduce at present the true intensity of each jerk/impulse virtually impossibly. However, by utilizing the calculated corrections, it is possible to learn the depths of the origin/hearths of the iterative impulses which, in spite of separate/individual deviations, on the average will nailuchshim form approach true values.

Determination h'_{KI_0} (second approach/approximation). The given values of corrections are taken into account in the nomogram (Fig. 81), comprised specially for determining the depth of the origin/hearth of the iterative impulses of Tashkent earthquake. With the aid of nomogram all the values h_{KI_0} pereopredeleny anew.

Let us pause at the final estimation of error h_{KI_0}, which easily can be obtained taking into account formula (58) and of data of this work on the dispersion of estimations k and I_0. With $\delta k \approx$ 0.3-0.4 and $\delta I \approx 0.4$ we will obtain $\delta \lg h \approx 0.2$, whence the error in determination of the depth of origin/hearth h_{KI_0} comprises approximately 1.5 times. It is possible to assume that this estimation is sufficiently careful, since for all 173 cases of consistent determination h_{KI_0} and $h_{нс}$ difference $h_{KI_0} - h_{нс}$ exceeded the indicated limit only into 13%/o of cases. One should focus attention on the specificity of the accuracy of definition h_{KI_0} : if for the majority of instrument/tool methods for entire interval of depths is retained constant/invariable the absolute error of definition h_{KI_0} it does not depend on depth, while the absolute error increases with depth.

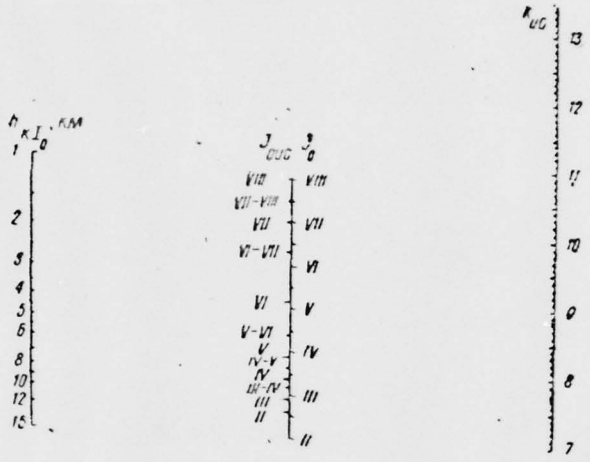
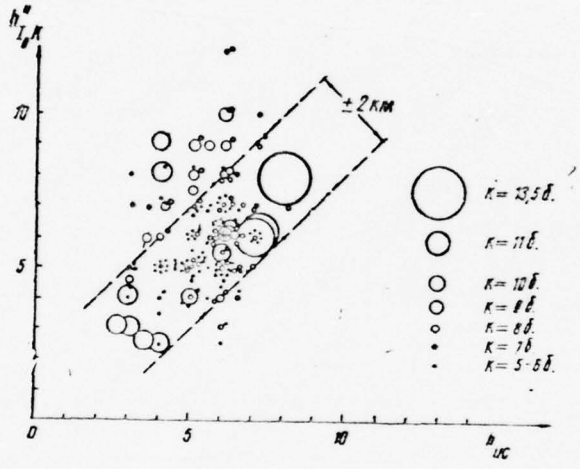


Fig. 81. Nomogram for determining the depth of the origin/hearth of the iterative impulses of Tashkent earthquake from energetichekomu class K_{HC} and an intensity in epicenter I_{oHC} (according to data of the catalog of the iterative impulses of the institute of seismology the A.S. of the Uzb.SSR). Comprised N. V. Shebalin, 1968 (I_0 - probable intensity).

Fig. 82. Comparison of the depth of the origin/hearths of iterative impulses, determined in an instrumental manner ($h_{ис}$), with the depth, determined in a composite makroseysmicheskim manner ($h_{КЛ}$).



In this case, for very small depths, the accuracy of determination from a formula of type (58) proves to be above, but for large - is lower than the accuracy of instrument/tool methods.

As a result we obtained the final estimation of the depth of the origin/hearth of iterative impulses, made taking into account all definitions, and also the given observations and estimations. The determination of the depth of origin/hearth is executed for 403 iterative impulses.

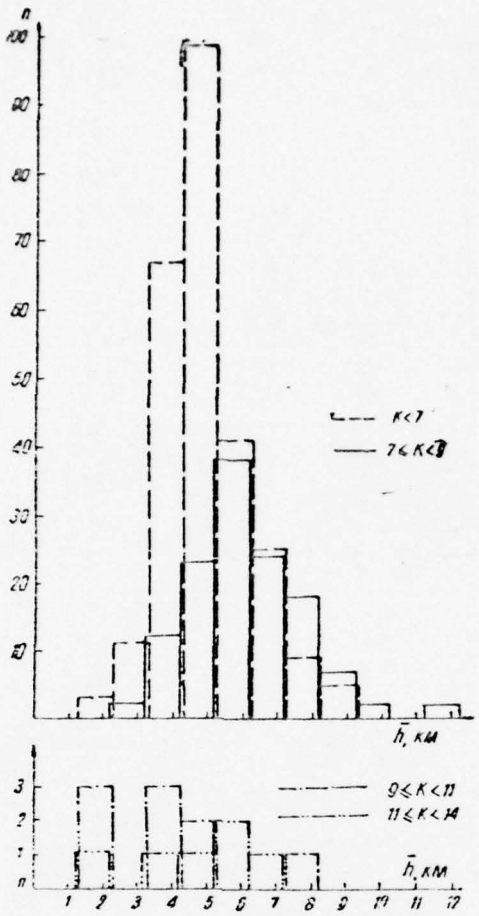


Fig. 83. Number distribution of jerk/impulses of different energy classes at the depth of origin/hearth.

The obtained results will agree well with instrument/tool data of the institute of seismology (Fig. 82).

The distribution of the origin/hearths of iterative impulses according to depth detects the definite dependence on the class of jerk/impulses (Fig. 83). According to our data, the strongest iterative impulses ($9 \leqslant K < 12$) are arranged in focus region sufficiently evenly, with certain gravity to less depths, weaker jerk/impulses gravitate to depths 5-6 km ($7 \leqslant K < 9$) and 3-5 km ($K < 7$). This depth, as most probable, characterizes those jerk/impulses for which is not determined the value to ballinkti.

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Interest is of maximum dependence on the depth of the origin/hearth of the maximum class of the jerk/impulses, noted at this depth (see Fig. 27): if jerk/impulses at depth 3-10 km approach limiting curve (Shebalin, 1969)

$$M_{max} \leqslant 3{,}3 \lg h + 3{,}1$$

or

$$K_{max} \leqslant 5{,}9 \lg h + 9{,}6,$$

although they do not reach it approximately to 1.5 classes, then for finer ($h < 3$ km) jerk/impulses a characteristically abrupt decrease in the maximum energy approximately by 5 orders. This makes it possible to make the conclusion that the zone of iterative impulses took the

layer of sedimentary rocks, differing in terms of substantially less prochnost'yu.

STATISTIC STUDY OF THE SEQUENCE OF THE EMERGENCE OF ITERATIVE IMPULSES.

Concerning the povtoyaemosti of earthquakes, is published the work of A. A. Lyapunov and S. M. Pardyushincy (1950), where is analyzed the sequence of the torque/moments of the emergence of earthquakes for explanation, are the earthquakes in two nonintersecting time intervals the random events, independent of each other. Is analyzed below the sequence of the aftershocks of Tashkent zamletryaseniya. Are here possible three hypotheses: the appearance of an earthquake into time interval (t_1, t_2) 1) stimulates, 2) it impedes, 3) it does not affect the appearance of an earthquake into the following time interval (t_2, t_3). The physical sense of these hypotheses the is following. The first hypothesis of spravedlva when the emergence of earthquake, caused by the disequilibrium in origin/hearth, will draw zasoboy the appearance of a new disequilibrium somewhere in the neighborhood of origin/hearth. The second hypothesis - if for the emergence of earthquake is necessary certain accumulation of instability which is permitted at the torque/moment of earthquake and is absent for a certain period of time after earthquake. The third hypothesis is valid, when both processes, described above, seemingly balanced each other.

The solution to the question concerning which hypothesis more plausible, it is possible on the basis of the statistical analysis of the torque/moments of the emergence of earthquakes. We made a statistical check of the admissibility of the third hypothesis, after supplementing it by some assumptions of the character of the "uniformities", which usually are made in probabilistic problems. Then the full/total/complete formulation of the checked hypothesis is the following: a) to each (t_1, t_2) answers probability $P(t_1, t_2)$ of the emergence of earthquake, that depends only on the length of time interval:

$$P(t_1, t_2) = P(t_2 - t_1).$$

b) the probability of separate/individual event for a small time interval is:

$$P(\Delta t) = k \cdot \Delta t + 0(\Delta t),$$

where k = const > 0 and $0(\Delta t)$ - infinitesimal, higher order, than Δt.

c) random events $\xi_1(t)$, $\xi_2(t)$, ..., that consist of the appearance of earthquakes into the nonintersecting time intervals, are independent of each other.

In this case

$$P(t) = 1 - e^{-kt}. \qquad (66).$$

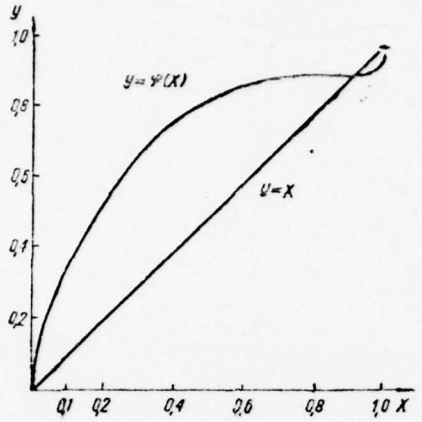

Fig. 84. The theoretical law of distribution (y = x) and is the empirical curve of y = φ (x).

For the comparison of an empirical series of the torque/moments of earthquakes with the theoretical law of distribution (66) we will use Kolmogorov's criterion. We must study the deviations of the theoretical function F (t) of the empirical $F_n(t)$.

Since F (t) - continuous function and the continuous monotonic conversion of axis t does not change difference $|F - F_n|$, instead of t and x as new variables it is possible to take t' = F (t) and x' = F (x).

Let $\tau_0, \tau_1 \dots \tau_n$ be torque/moments of the emergence of earthquakes in number N + 1 (N = 850). Let us compute the following values

$$\delta_i = \tau_i - \tau_{i-1}, \; f_i = 1 - e^{-\frac{N}{\tau_N - \tau_0}\delta_i},$$

then, on the strength of that which was stated above, random variables f_i are subordinated to the law of the distribution:

$$P\{f_i < x\} = x.$$

Let us construct (Fig. 84) the theoretical law of distribution y = x and the empirichesuyu curve:

$$y = \frac{S(x)}{N} = \varphi(x), \quad \text{where} \quad S(x) \quad \text{- the number} \quad f_i \leqslant x.$$

In the case of the correctness of hypothesis both curves must be close to each other. The degree of nearness of curves let us estimate according to Kolmogorov. Let us examine random variable $\eta = \max |y - \varphi(x)|$, the law of distribution, which is bygone is found by Kolmogorov:

$$K_n(\lambda) \approx 1 - \Phi(\lambda) = 1 - \Phi(\eta\sqrt{N}).$$

If probability $K_n(\lambda)$ turns out to be sizable, then it is possible to count that the results of selection do not contradict assumption about its equipment with distribution $F(x)_n$. Our hypothesis is permissible. With small $K_n(\lambda)$ we obtain reverse assertion. In our case: $\eta = \max|y - \varphi(x)| = 0{,}43$, $\lambda = \eta\sqrt{N} = 12{,}6$,

$$\Phi(12{,}6) \approx 1, \quad K_n(\lambda) \to 0.$$

consequently, our hypothesis is inadmissible.

If curve/graph φ (x) is risen considerably steeper than the straight line y-x, and further remains in essence higher than this straight line, then the true value P (t) for small t substantially more than this requires formula (66). This confirms the first hypothesis. On the contrary, if the curve/graph y = φ (x) is arrange/located and in essence remains arzchitel'no lower than the straight line y-x, then the true probabilities P (t) with small t prove to be less than this it requires law (66).

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In our case (see Fig. 84) curve/graph φ (x) is located significantly higher theoretical straight lire y-x. This bears out the fact that the appearance of an earthquake into time interval (t_{i-1}, t_i) stimulates the emergence of earthquake into the subsequent time

interval (t_i, t_{i+1}), i.e., is confirmed the first of the hypotheses in question. The results of the work of A. A. Lyapunov and S. M. Pandyushinoy (1950) and our coincide.

SEYSMOAKUSTICHESKIYe INVESTIGATIONS OF ITERATIVE IMPULSES.

On the initiative of the institute of physics of earth the AS USSR and on the request of central seismic station "Tashkent" by the group of the colleagues of the geophysical laboratory of the Mining Institute im. A. A. Skochinskiy and Tsentral'noy of the scientific research seysmoakusticheskoy station of Donbass is carried out the series of the observations of seysmoakusticheskikh phenomena in the period of the intense activity of iterative impulses. Tashkent earthquake from 1 to 19 June 1966 in two point/items: the first - in the territory of central seismic station "Tashkent" with 10 hours, 1 June to 20 hours, 5 June (time Tashkent), the second - near Ankhorskoge bridge (" Urda"), in epicentral zone with 10 hours, 8 June to 22 hours, 19 June.

Equipment. The channel of registratsii (Antsyferov, Pereverzev, 1964) included seismic receiver, preliminary transistor amplifier of the type of UW-2, two magnetic recorder of the type of MAG-8 and recorders N-370 m. In the diagram of UW-2, is replaced the block capacitor, which made it possible to enlarge its frequency characteristic to the side of low frequencies to 70-100 Hz, while to the side of high frequencies - to 3000-5000 Hz. Frequency and the

dynamic characteristics of the circuit of recording were monitored in the process of field observations by means of the feed of the signals of synchronous generator of the inlet of the amplifier of UW-2.

In work on the first observation station, the recording was carried out simultaneously according to two circuits: in one circuit as seismic receiver served the geophone of the type of SGD-6, established/installed in blowhole 25 m deep, in another it served the geophone SGD-3M, arranged/located in the basement of seysmostantsii at a distance approximately 50 m of blowhole. The need for the simultaneous work of two circuits is caused by the high level of acoustic noises in shallow blowhole. Were accepted into consideration only the those seysmoakusticheskiye phenomena, which were recorded by both circuits synchronously. On the second observation station, was utilized the seismic receiver of the type of SPED-56, sealed into the housing of inclinometer and emitted to the face of 500-metric blowhole. Established/installed that the acoustic noises do not reach this depth. Frequency characteristics and the sensitivity of all used seismic receivers are determined during calibrating on vibroplatforme.

Time mark was conducted by continual sounding from generator with the aid of the contact chronometer, which was being monitored at the signals of precise time.

To avoid overheating, the tape recording was conducted alternately on two magnetic recorders. The duration of notation with

each magnetic recorder was 45 min. The sections of notation with seysmcakustichesimi phencmena were cut cut ard were installed together for the subsequent detailed investigatians.

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Table 16. Distribution of a quantity of earthquakes and seysmoakusticheskikh phenomena according to various days.

(1) Дата (1966 г.)	(2) Количество землетрясений	(3) Бальность (М-менее)	(4) Количество сейсмоакустических явлений		
			(5) всего	(6) первого класса	(7) второго класса
2.VI	1	М 2	6	5	1
3.VI	2	2; м 2	21	11	10
4.VI	6	М 2; 4, 5; 2; 3—4; 2; м 2	22	11	11
5.VI	6	7; м 2; м 2 4, 5; 2; м 2	21	14	7
8.VI	2	4; 2	19	7	12
9.VI	5	М 2; м 2; 4; м 2; м 2	34	18	16
10.VI	1	3	48	18	30
11 VI	1	2	17	6	11
12.VI	1	2	20	9	11
13.VI	3	2; 3; 3	21	13	8
14.VI	1	2	14	5	9
15.VI	4	2; м 2; 3; м 2	14	8	6
16.VI	3	М 2; м 2; 3	23	6	17
17.VI	2	М 2; 4	13	4	9
18.VI	1	М 2	7	2	5

Key: (1). Date. (2). Quantity of earthquakes. (3). Bal'nost' (M- is less). (4). Quantity of seysmoakusticheskikh phenomena. (5) in all. (6) the first class. (7) the second class.

Recordings. For time of observations (SS "Tashkent" it recorded 39 earthquakes siloyu from 7 to 2 balls and less. By Seysmoakusticheskoy equipment it is recorded for this time of 300 acoustic phenomena which can be subdivided into two classes. The first - these are the single shocks of different intensity. As a rule, the most powerful of them coincided with those noted seysmostantsiyey repeated push. Large quantity of phenomena of this class recorded seismic equipment. The second class is the prolonged (several tens of seconds or several minutes) accustic vibrations, which recall hum, rumble, the distant unrolling/reelings of thunder. These phenomena in no way were noted seysmostantsiyey.

Table 16 gives the distribution of quantities of earthquakes and seysmoakusticheskikh phenomena according to various days. Data of this table do not give grounds for the establishment of direct/straight communication/connection between the seismic and seysmoakusticheskoy activity, at least within the limits of the interval, in extent/elongation of which are carried out the observations. Most probable this interval is too small for the possibility of the establishment of tacy communication/connection. It is not noted also an increase in the seysmoakusticheskoy activity before separate/individual powerful push earthquakes. On the contrary, before the "-scale-number jerk/impulse on 4 June was observed six hour calm, whereas during other days seysmoakusticheskiye phenomena were noted on the average almost hourly. It is possible to assume that in the extent/elongation of this prolonged (from the viewpoint of this seysmoakusticheskoye mode/conditions) calm, in the

region of seismic center were accumulated the elastic strains, which revealed then by an especially powerful jerk/impulse.

Table 17. Comparison of times of the vstupleniy of seysmoakusticheskikh momentum/impulse/pulses with seismic push.

(1) Июнь, 1966 г.	(2) Время (час., мин.)	(3) Эпицентральное расстояние, км	(4) Глубина очага, км	(5) Гипоцентральное расстояние, км	(6) Время вступления продольной волны				(7) Разность $t_2 - t_1$, сек.
					(8) в очаге	(9) на станции № 14	(10) на ст. Урда, t_2	(11) сейсмоакустическ. волна, t_1	
12	07,15	3,3	3	4,1	51,2	52,0	52,6	52,6	0,0
13	10,10					56,4	56,2	56,1	+0,1
14	22,19	2,1	3	3,2	36,7	38,1	37,8	37,0	+,08
15	01,17	4,6	3	5,2	22,0	23,4	23,2	22,9	0,3
15	08,39	0,9	3	2,7	34,0		34,9	34,1	+0,8
17	12,22	2,5	0—4	3,5	55,6	56,8	56,6	56,6	0,0

Средняя разность + 0,33 сек.

Average difference +0.33 s.

Key: (1). June. (2). Time (hour, min.). (3). Epicentral distance, km. (4). Depth of origin/hearth, km. (5). Hypocentral distance, km. (6). Time of arrival of longitudinal wave. (7). To Raznsot' $t_2 - t_1$, s. (8) in origin/hearth. (9) on stnatsii. (10) on stage Urda. t_2. (11) seysmoakustichn. wave, t_1.

The arrival of the low-frequency seismic wave P sometimes coincides with the arrival of high-frequency seysmcakusticheskoy wave, but it can delay on 0.3-0.8 s. The subjective perception of sound and jerk/impulse confirms this observation. Usually operator heard the hum of jerk/impulse earlier than perceived low-frequency earth tremors. Is explained this, apparently, by the fact that the seysmoakusticheskiye vibrations are excited with the very beginning of the discontinuity which during further development causes more powerful low-frequency vibrations.

Analysis of notations. Above it was mentioned, that all the observed seysmcakusticheskiye phenomena clearly are divided into two classes: momentum/impulse/pulses and prolonged oscillating processes (hums) (Fig. 85). The visible frequency of waves in these notations varies within limits 80-120 hz. i.e. it lie/rests at the sacy lower graitsy of the passband of seysmcakustichescy equipment. On the notation of some earthquakes and shocks, are noted two waves of the approximately equal intensity, divided by time interval 0.2-0.45 s. The origin of the second wave unlike the first (straight line) to establish/install is difficult. It is possible, it connected with the exchange of waves on boundaries in sedimentary thicker.

The oscillograms of the phenomena of the second class (hums) consist of continuous pulse trains, podolzhayushchikhsya, attenuating and being renewed, to 15 minutes (Fig. 86). The visible pulse freguency on the first observation station was 70-120 Hz, on the second - 120-160 Hz.

For the more detailed determination of the frequency spectra of the recorded seysmoakusticheskikh phenomena at first from oscillograms are determined the maximum amplitudes of notations. If amplitude did not exceed the maximally undistorted amplitude, determined in the dynamic characteristic of equipment, then notation was utilized for the frequency response analysis, which was being carried out by the repeated reproduction of magnetic recording with magnetic recorder. From the output of magnetic recorder the signal of podavalna the analyzer of the noise spectrum of AW-2 m, the maximum amplitude at output of which was observed on oscillograph. The obtained spectrum of the speed of displacement was recounted according to known formulas into the energy or spectrum of density energiv to observation point. The value of energy density was computed according to the formula:

$$\varepsilon = \rho V \sum S_\xi \Delta f,$$

where ρV it was computed the acoustical stiffness of medium; f are a frequency, Hz; S_ξ - the value of spectral density.

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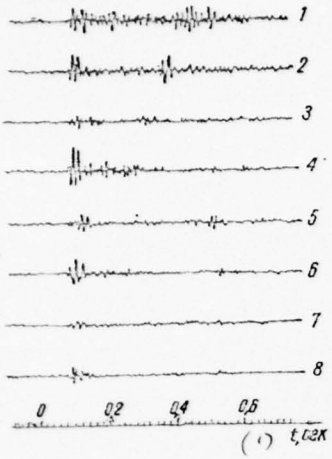

Fig. 85

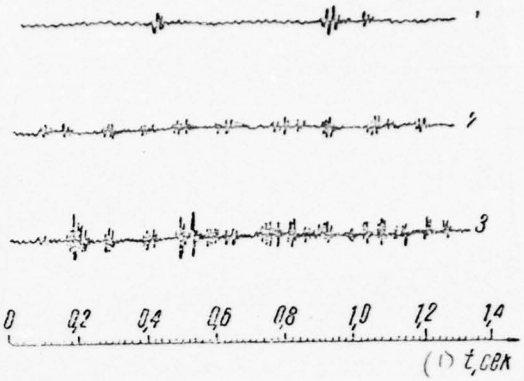

Fig. 86

Fig. 85. Oscillograms of the phenomena of the 1st class. Earthquakes: 1 - 8 hour 38 min., 5 June (4-5 6); 2 - 8 hour 48 min., 5 June (26); 3 - 8 hour 58 min., 5 June (m. 26.); 4 - 18 hours 51 [redacted] min., 8 June (26); 5 - 10 hours 10 min., 13 June (36); 6 - 12 hours 22 min., 17 June (46); 7 - 0 hour 49 min., 17 June; 8 - 1 hour 07 min., 17 June.

Key: (1) t, s.

Fig. 86. Sections of the oscillograms of the phenomena of the 2nd class. Grating/crash: 1 - 05 hours 09 min., 9 June; 2 - 13 hours 10 min., 10 June; 3 - 7 hours 38 min., 10 June.

Key: (1) t, s.

For earthquakes and shocks (phenomena of the first class) the character of the frequency spectra is almost identical (Fig. 87). Consequently, the phenomena of the first class are the very weak earthquakes, neotmechaemye by low-frequency seismic equipment due to its insufficient sensitivity. The frequency spectrum of these phenomena is the inclined straight line, which characterizes a powerful decrease in the high frequencies in the spectrum) energy density decreases by an order with an increase in the frequency on 70-80 Hz).

The spectrum of the phenomena of the second class has another character: is observed the maximum of the spectrum at frequency 120-160 Hz, on both sides from which the spectral density sufficiently sharply drops. The high frequency of these phenomena testifies to a comparatively small distance of geophone from driver. It is possible that these phenomena are connected with the processes of the failure of the rock/species of sedimentary covering.

The findings make it possible to approximately evaluate the full/total/complete energy spectrum of earthquakes. For determining the magnitude of absorption of elastic waves it is possible to use S. I. Vasiliev's data (1962). During the calculation selected minimum value of the decrement of absorption of $V = 0.01$ (Table 18). Acoustical stiffness ρV is accepted equal to $5 \cdot 10^5$ g/cm^2•s. It is evident that upon consideration of absorption the density of the frequency spectrum in the range of accustic frequencies becomes approximately constant, and the energy, transferred by these

vibrations, is equal or close to the energy, calculated from low-frequency seismic data. Apparently, during earthquake are excited the seismic fluctuations of the very broad band of frequencies, but high-frequency oscillations sufficiently rapidly attenuate and the only small depths of the origin/hearths of jerk/impulses contribute to the fact that on surface is noted the perceptible level of seysmoakusticheskikh oscillations.

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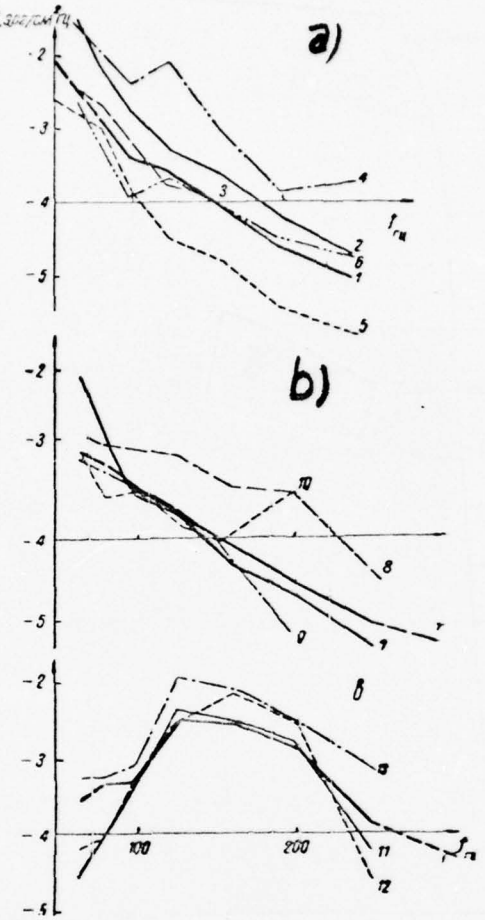

Fig. 87. Spectrum of the energy density of earthquakes (a), of shocks (b) and of phenomena II class (c). 1 - the average spectrum; earthquake; 2 - 12 hours 22 min., 17 June; 3 - into 22 hours 19 min., 14 June; 4 - 08 hours 39 min., 15 June; 5 - 08 hours 38 min., 5 June; 6 - 08 hours 48 min., 5 June. Shock: 7. 00 hours 49 min., 17 June; 8 - 09 hours 35 min., 13 June; 9 - 08 hours 36 min., 11 June; 10 - 14 hours 02 min., 10 June. Grating/crash: 11 - into 03 hours 58 min., 17 June; 12 - 13 hours 10 min., 10 June; 13 - into 02 hours 32 min., 12 June.

Key: (1) lg $\mathcal{E}$, erg/cm^{2}gts.

apparently, is connected with the disturbance/breakdown of the uniformity in time, which is one of the basic initial axioms of Poisson distribution.

Negative binomial distribution is obtained also for the seysmoakusticheskikh phenomena, observed in the coal beds of Donbass, dangerous on the ejections of carbon and gas; its transition to geometric is realized in this case when selecting time interval, equal to 1-1.5 hours (Antsyferova, 1967). Thus, from the viewpoint of mathematical statistics, the iterative impulses of Tashkent earthquake and the seysmoakusticheskiye momentum/impulse/pulses of carbon shaft/mines have common/general/total features, although they are distinguished by characteristic time scale (approximately on one and one-half order).

For the focus zone of the Tashkent earthquake of the reason for nonsimultaneity in time, can be explained by the neodnorodnost'yu of the three-dimensional/space state of rocks in the region of origin/hearth, by the complexity of their geological structure and by the presence of a larger or less quantity previously realized discontinuities of continuity in the different places of focus zone.

On the possibilities of the seysmoakusticheskogo forecast/prediction of earthquakes. As a result of seysmoakusticheskikh observations in conjunction with recording the iterative impulses of Tashkent earthquake established/installed any

pcssibility of forecasting the torque/mcment of the approach/approximatien cf separate/individual jerk/impulse. This, hcwever, not that means that is impcssible the seysmoakusticheskiy fcrecast/prediction of the danger of the apprcach/approximation of the first, kasic jerk/impulse cf earthquake. Seismic mcde/conditicns in the period cf iterative impulses qualitatively differs from the mcde/cenditions, which existed tc the first jerk/impulse, transitien frcm cre mcde/conditions tc another can ke revealed in high-frequency seysmoakusticheskoy range cersiderably mcre sharply than in lcw-frequency. This assumption is confirmed by scme, unfortunately by the very scarce, direct clservaticns, carried cut in 1950 in Garmskcy seysmoaktivnoy range. Recording was cenducted with the aid of the ceophcne cf SGD-2 (Antsyferov, 1964), of ustancvlennona kasic granite rcck/species in the gallery cf Garmskcy ceophysical station. The signal cf geophone after amplifier was detected and was record/written with the aid cf low-frequency mirror galvancmeter tc the phctc-paper, placed cn the drum of usual seismic registrira RS-1. As a result was recerd/written not the iritial signal, kut cnly its envelope, which gave the sufficiently precise cercept akcut the time of arrival cf mcmentum/impulse/pulse and very approximated - akcut its form.

Statistics of seismic and acoustic jerk/impulses. Some supplementary data for the comparison of seismic pheromena with seysmcakusticheskimi are acquired as a result of statistical processing a considerable quantity (it is more than 600) of iterative impulses of Tashkent earthquake for the period with 26 April through 11 November 1966. Established/installed that the distribution of jerk/impulses in time satisfies the so-called "negative binomial distribution" of the probabilities:

$$f(k, r, p) = (r + k + 1)p^r q^k,$$

where k = 0, +1, +2, $0 < p \leq 1$ + q = 1.

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The simplest form the distribution of seismic jerk/impulses acquires for the 48-hour intervals of countdown: it is reduced to the so-called "geometric distribution" of the probabilities:

$$f(k, 1, p) = pq^k,$$

where k it is reduced a quantity of jerk/impulses, which are necessary to time interval, equal to two calendar days. In the given more common/general/total formula, spravledlivoy for any arbitrarily vybranykh time intervals, the value is equal to the multiplicity of assigned time interval with respect to 48-hour.

The geometric distribution of iterative impulses very substantially deviates from the Poisson distribution, which,

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Table 18

The calculated values of energy in the crigir/hearth repeated.
64-250

(1) Июнь, 1966 г.	(2) Время (час., мин.)	(3) Баллы ность	(4) lg $E_1 - K_1$ по сейсмологическим данным	5 Частота, 64	80	100	125
4	04,12	4,5	8,5	410	210	47	180
5	08,38	4,5	8,5	175	195	51	21
5	08,48	2	6	415	195	68	280
12	07,15	2	6	186	80	75	95
14	22,19	2	6	270	225	104	45
15	01,17	2	6	350	1620	1550	330
15	08,39	3	7	1600	740	470	1470
17	12,22	4	8	2500	830	800	170

Key: (1). June, 1966. (2). Time (hour, min.). (3). Intensity. (4). lg $E_1 = K_1$ according to this smolcgicheskim data. (5). Fiequency, Hz. (6). Density of vnergii, erg/cm^2. (7). Gipctsentr. distance, km. (8). Energy, .

Гц 160	200	250	(6) Плотность энергии, эрг/см^2	(7) Гипоцентр. расстояние, км	(8) Энергия, E_0	lg $E_0 - K_0$	$K_1 - K_0$
255	255	600	3,6	3,7	$6 \cdot 10^5$	5,8	2,7
30	20	37	0,61	4,4	$1,5 \cdot 10^5$	5,2	3,3
415	510	1800	8,3	5,3	$2,8 \cdot 10^5$	6,4	—0,4
95	9	—	0,63	4,1	$1,3 \cdot 10^5$	5,1	0,9
63	490	—	1,8	3,2	$2,3 \cdot 10^5$	5,4	0,6
560	210	500	7,0	5,2	$2,4 \cdot 10^5$	6,4	—0,4
290	90	300	6,2	2,7	$6 \cdot 10^5$	5,8	1,2
170	111	108	4,1	3,5	$6 \cdot 10^5$	5,8	2,2

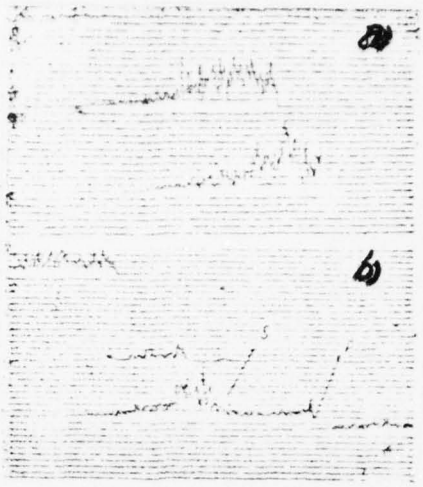

Fig. 88. Of the notations of seismo-acoustic impulses at Garmskoy geophysical station according to the method "of envelope" (a) are the local momentum/impulse/pulses; b) earthquake).

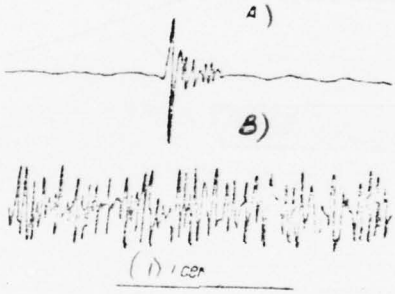

Fig. 89. Oscillographic notation seismo-acoustic phenomena with Garmskoy station (A) momentum/impulse/pulses; B) prolonged process is hum).
Key: (1) 1 s.

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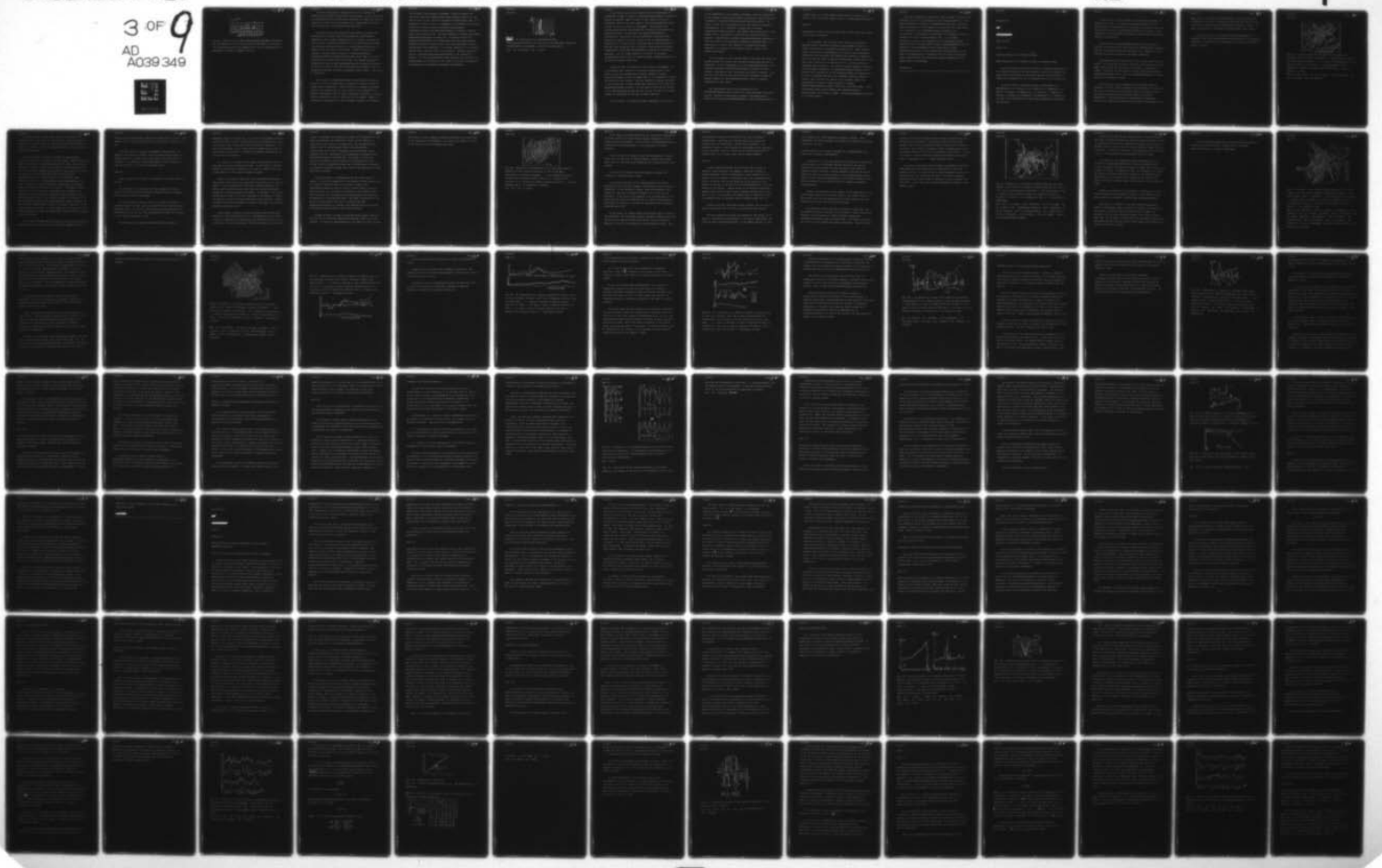

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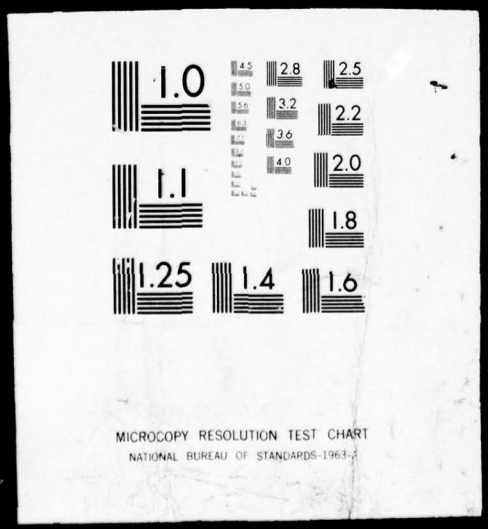

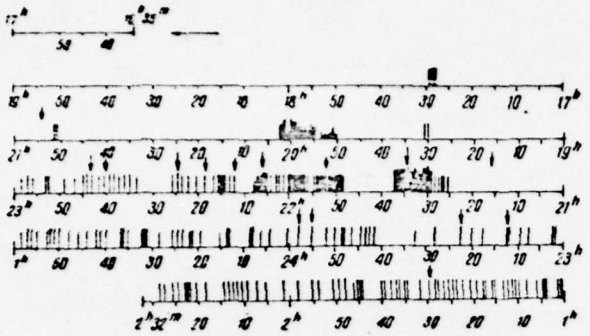

Fig. 90. IMpul'sy and the hums, which preceded and which acccmpanied the jerk/impulses of the Tcvil'-Dcrinskcgc earthquake on 22 November 1950 (rifleman/gunners under fiksovcy line ncted the jerk/impulses cf earthquake, recorded by Garmskoy statien).

For some earthquakes in yepitsentral'nym up to 200-300 km distance whose spectrum sufficiently high-frequency, on the film/strip of seysmoakusticheskoy recording were obtained the completely distinct notations on which were distinguished the torque/moments of arrival both longitudinal and transverse waves (Fig. 88).

Occasionally notation according to the method of envelope was duplicated by the usual, undetected notation by high-frequency galvanometer with natural frequency 800 Hz. However, in connection with the large expenditure/consumption of the photo-paper, necessary for obtaining the solved notations of high-frequency processes, the volume of this recording is very small. Flowed not less it was possible to obtain several notations of separate/individual seysmoakusticheskikh momentum/impulse/pulses (Fig. 89a), or to write prolonged sonic potsess (hum) (Fig. 89b). The visible fundamental frequencies of the recorded seysmoakusticheskikh processes lie/rested at range from 45-50 to 250-300 Hz, whereupon the frequency range of registering apparatus was bygone knowingly somewhat wider: from 25-30 to 350-500 Hz.

Some results of seysmoakusticheskikh observations in Garmskoy range are of direct interest for the problem of prognoza in time of intense local earthquakes. Unlike recording in Tashkent, Garmskaya recording was carried out not in the period of the aftershocks of powerful earthquake, while in usual, relatively calm period. Powerful local earthquakes for time of recording are not bygone. However, in tovil6-Dore, approximately 25 km of Garmskoy station, on 22 November

1950 occurred "-scale-number earthquake. Figure 90 depicts the results of recording seysmcakusticheskikh phencmena during the time from 16 hours 36 min. (here and thrcughcut Greenwich mean time) on 22 Ncvember to 2 hours 32 min., 23 November. The direction in which one should read notation shcwn by horizontal arrcw/pcinter, seysmoakusticheskiye momentum/impulse/pulses are shcwn by vertical prines under fiksovoy line. The total quantity cf separate/individual mcmentum/impulse/pulses is abcut 200. In natural nctation the ncmentum/impulse/pulses so cf intnesivny that their upper bcundary disappeared frcm the field cf view. With perecherchivanii they are ccnditicnally shown identical. On the same film/strip it is recorded several hums by duration frcm 2 tc 20 minutes. They are reprcduced with the preservation/retention/maintaining cf the character of nctaticn. By the rifleman/gunners under fiksovcy line are shcwn the tcrque/moments of the arrival of the waves cf the first jerk/impulse cf earthquake and subsequent vcvtcrnykh jerk/impulses.

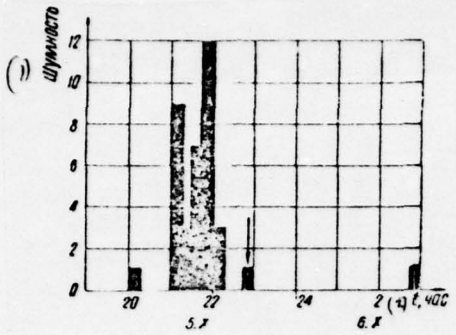

Fig 91. [redacted]. The distribution of seysmoakusticheskikh momentum/impulse/pulses in the time before the weak local earthquake (torque/moment of earthquake is noted by arrow/pointer).

Key: (1). Noisiness. (2). t, hour.

On the initial part of the notation (to the torque/moment of earthquake) it comes a total of 8 momentum/impulse/pulses, distributed in time as follows: about 17 hours 30 min. (almost 3.5 hours to earthquake) appeared the first group of four momentum/impulse/pulses, 19 hours 30 min. (1.5 hours to earthquake) - an additional two momentum/impulse/pulse, and finally for 3 minutes to the arrival of seysmichesoy wave - an additional two momentum/impulse/pulse. Earthquake was anticipated also were prolonged by the hum, which initiated 19 hours 44 min. (for 1 hour 10 min. do zemletr4seni4) i zaoncivwims4 v 20 hours 03 min. The amplitude of the oscillations of this hum first grow/rose, then it dropped, being omitted at various torque/moments lower than the threshold of response of registering apparatus. But the common character of process, if we smooth nonuniformities with period to one-two minutes, gradually growing with the sharply breaking itself end.

20 Hours 54 min. is recorded the first shock of earthquake. It is interesting that neither it nor second, followed after 21 min. after it, were not accompanied by acoustic impulses in Garme. Full/total/complete silence is bygone also in the interval/gap between the first and second shocks. Then the following 13 shocks, recorded on this film/strip, occurred against the background of the very high seysmoakusticheskoy activity: to each shock it comes on the average in 15 momentum/impulse/pulses, and two of them (3-1 and 5-1) occurred against the background of the hums of large intersity.

In this respect is observed the great similarity to the picture

of the aftershocks of the Tashkent earthquake, which is supplemented by the numerical relationship between a quantity of jerk/impulses and a quantity of seysmoakusticheskikh momentum/impulse/pulses. The latter in both cases approximately by an order exceed a quantity of jerk/impulses. It is possible to assume that the lively seysmoakusticheskaya activity - the index of the excited state of the seismic joint, consequence of which are the numerous iterative impulses. Unfortunately, recording seysmoakusticheskikh phenomena in 1950 is finished on the described film/strip; therefore there is no possibility to conduct the comparison of accustic and seismic phenomena in the period of the damping of mass - also as for a Tashkert earthquake.

In the relation to the forecast value of the given materials, the interest causes the seismic hum, recorded approximately per hour to earthquake. In all probability, it is the merging/coalescence of the separate/individual momentum/impulse/pulses, following one after another so frequently, that on notation they cannot be solved. In by taom the case, this hum one should consider equivalent at least of several hundreds of momentum/impulse/pulses, which is complete uncommonly for this region.

The pure/cleaner case of the reanimation of the seysmoakusticheskoy activity before the local earthquake illustrates Fig. 91. Against the background of almost full/total/complete stability (one-two momentum/impulse/pulse in the extent/elongation of

several hours on 5 October 1950) in period with 21 hours on to 22 hours 15 min. is recorded compact group of 34 momentum/impulse/pulses.

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Approximately through half-hour after this is noted weak local (about 2-x of balls) earthquake.

On 13 November 1950 14 hours 26 min. 39 s. in the region of Garmskoy station occurred the vertical jerk/impulse by force to 3 balls, that was being accompanied by anechoic hum. Audio equipment noted its arrival by approximately 16 s. earlier than seismographs (recall that the analogous lead/advances were observed in Tashkent). The seric process, which accompanies jerk/impulse, lasted about 40 s., then, after interruption by duration to 50 s., it was renewed and continued about 125 more s. But there is special interest completely in the uncommon reanimation of seysmoakusticheskoy activity, which preceded this jerk/impulse in the extent/elongation of several hours. In spite of interruptions into the notations, caused by technical reasons, after ten-hour the period of the recording before the jerk/impulse is counted several hundreds of distinct momentum/impulse/pulses, whereas others are fused into groups. After jerk/impulse began gradual damping and seysmoakusticheskiy mode/conditions it returned to usual: several momentum/impulse/pulses in a 24 hour period.

The given examples are too few in number in order to serve as the doubtless proof of the possibility of the forecast/prediction of the local earthquakes according to seysmoakusticheskim data. Moreover another nevyyasneno is the assumed to be time from the torque/moment of an increase in the seysmcakusticheskcy activity to the torque/moment of earthquake, the intensity of earthquake, epicentral distance, the depth of origin/hearth, etc. It is possible, apparently, to assert just research on the seysmcakustricheskogo mode/conditions of seismic active regions nelesperspektivno from the viewpoint of the possibility of the investigation of the weather-forecast signs of the approaching local earthquake, or, at least the determination of transition from the calm to the excited state, connected with the considerably larger probability of the manifestation of earthquake.

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Pages 164-200.

Chapter IV.

RESIDUAL STRAINS ON THE SURFACE OF the EARTH.

CRACK FORMATIONS ON THE SURFACE OF EARTH IN EPICENTRAL RANGE.

For the explanation of the skin effect of Tashkent earthquake and its communication/connection with geology of region, is organized the large group of geologists and scientific workers of the institute of geology and geophysics im. Kh. M. Abdullaeva the A.S. of the Uzb.SSR.

In the collection of factual material, participated M. A. Akhmedzhanov, O. M. Borisov, D. Kh. Yakubov, R. N. Ibragimov, A. A. Aripov, A. Kadyrov, K. Rakhman, by O. P. Gor'kova, I. Usmanov, Yu. Shabaev, Z. Muradov, Kh. Abdullaev, B. Isakdzharov, I. V. Rubanov et al. data of the participants of group were generalized, supplemented and corrected.

Surface cracks in soil, asphalt, in hard-surfaced pavements of pavements and roads. The special feature/peculiarities of the manifestation of treinovatcsti on the surface of the Earth have great sigrificance and can be used during the study of the nature of the earthquake, and specifically, as auxiliary factor during microseismic division into districts.

The discovered and zakartirovannye cracks and the zones of fracture in solid ground at first glance are arrange/located along all possible directions without any order (Fig. 92). However, in their location was reveal/detected the determired regularity.

The maximum sizes of cracks reach 2 cm. in width even 15-20 m in length. In the majority of cases, they form the series of the rocker arms, which compose the small zones of fracture or the group of cracks. Largest (3 cm. into width, 50 m into length with vertical displacement/movement into 2 cm.) are established/installed in region Urdy by G. A. Mavlyanov (1969).

All cracks have uneven outlines and the vertical planes of incidence. They are noted on different constructions and buildings in the form of the gaping vertical cracks whose width from the hair of its basis/base grow/rises to the upper levels to the first centimeters. They are extracted in plan/laycut in determinate direction and destroy the upper levels of multistory buildings and the

upper parts of the single-stage construction. Many of them, well noticeable on the walls of buildings, hardly they are looked through in the soil of asphalt and the hard-surfaced pavement of roads. All these cracks with the subsequent iterative impulses were renewed.

A greatest quantity of fractures established/installed in epicentral zone, with removal/distance from epicenter, their quantity decreases. On orientation in plan/layout, are fixed the following 5 groups of cracks.

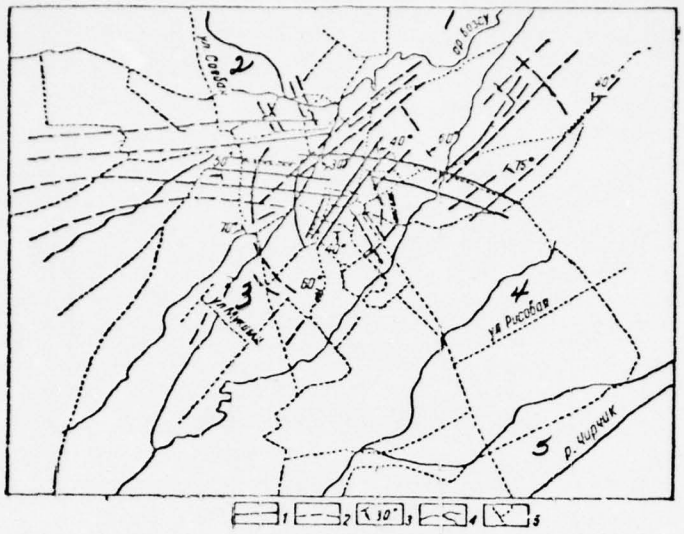

Fig. 92. Diagram of cracks on the surface of the Earth in the epicentral zone of Tashkent earthquake. 1 - crack in soil. asphalt and hard-surfaced pavements; 2 - the cracks in buildings, which do not reach the surface of the Earth; 3 - the cell/elements of the occurrence of cracks in buildings and constructions; 4 -rechnaya system; 5 - street.

Key: (1) comp. bozsu. (2) st. of Sogban. (3) st. illegible. (4) st. Is Risobaya. (5) r of Chirchik.

The first group - radial cracks diverge from epicenter to different sides. The cracks of this group are noted in essence in buildings and constructions and rarely in hard-surfaced pavement of roads and pavements. Range of propagation their 2-3 km of epicenter (region of Kazhgarki).

The second group of cracks is outlined in sublatitudinal direction in parallel to streets Navoi and Tabzak. Cracks clearly are fixed in asphalt and hard-surfaced pavement of roads, intersecting at their way: streets, ditchhes, artificial and natural constructions. One of the striking examples of the cracks of this group is the crack in asphalt st. of the Akhunbabaeva (in the region of the Ministry/department of foreign affairs of the Uzb.SSR), which intersects across st. of Akhunbabaeva, Lenina, Samarkandskuyu, the ditch of Ankhor, the central stadium of "Pakhtakor", the locating between them houses, the concrete enclosures of ditchhes, further is outlined to west to the ditch of Karakamysh and attenuates. In parallel to it are detected an additional five-six cracks, forming zone whose width is up to 2 km and whose extent is to 14 km. In the east the various cracks of this group reach the ditch to Karasu. Are most developed sublatitudinal cracks in epicentral zone, i.e., in the center section of the city. In the western part of the crack of this group, they have an azimuth of strike/course 85-100°, while in eastern they have 110-120°.

To the south habitable mass in region the streets of high-voltage (eastern part of the city) crack in essence are observed within the

walls of single-stage houses, only in the single cases - in soil. The general zone of fracture in this part of the city has a width to 2-2.5 km.

The third group is cracks of northeastern direction with the azimuth of strike/course 40-50°. They are fixed from the region of Turkoman market - on south west to the region of the park/fleet of "conquest" - on northeast on extent/elongation 8-9 km. Majority of them was outlined in the soil of epicentral range.

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Thus, the span of the zone of the fracture of the third group is 4-5 km.

The intersection of the cracks of three groups in the center section of the city coincides with the epicentral zone of earthquake in the region of Urdy and Kashgarki.

The fourth circular group of cracks is outlined in essence in buildings, rarely in soil. They gird epicentral zone and have almost concentric form. The cracks of this group are clearly expressed in the western part of the zone near pleystoseystovoy range, less clearly - on the eastern outskirts of city.

The fifth group of cracks is arranged along the ditchhes of

Burdzhar, Labzak, to Chorsu, etc. As a result of earthquake occurred settled phenomena in soil. Especially this is noticeable along a deep ditch Chorsu, which takes place from the stadium of Pakhtakor to the area of Akhunbabaeva, and or ditch navoi and Labzak, by the edges of water flows, are detected the cracks, the parallel configurations of the river-beds of channels.

As a whole of the system of the cracks, which arose on surface, they take the form of polygonal sections. In this case, the maximum failure of above-ground structures, as a rule, is timed to the zones of intersection of the cracks of different groups.

During the subsequent days after each considerable underground jerk/impulse, were carried out systematic observations of the state of cracks. It was explained that after each powerful aftershock (5-7 balls) crack experience/tested restoration and further development, increasing in extent/elongation and width. For example on the area of October market cracks in soil were extended to the magaina of "Takhir and Zukhra", but with the aftershocks they crossed building. Similar phenomena are observed everywhere (stadium of Pakhtakor, the region of executive committee, etc.).

Cracks within the walls of houses, buildings and constructions. According to the classification of V. T. Rasskazovskiy et al. (1967) of crack in buildings and constructions are subdivided into two groups - structural and structural/design. The first appear on the nondressd

joints of brickwork, are developed in angles and intersections of the walls of buildings, the rode/units of bords, on the outlines of apertures, in the joints of overlaps, etc. The structural/design cracks, named us seysmogennyui, destroy structural/design communication/connections of buildings and constructions and are connected with the overcoming of the considerable frictional forces and cohesion/coupling constructions. The cracks of this group slantwise intersect entire construction of buildings, they have X-shaped forms in load-bearing walls and the partitions of brickwork or elongated horizontally higher than the base the buildings and lower than garret overlaps.

The basic subject of investigation was the second group of cracks. For them were measured the cell/elements of the occurrence of the planes of discontinuities, as a result of which it was reveal/detect/exposeed, that the planes of cracks fall to the side from epicenter, i.e., the plane of incidence in the oblique cracks within the walls of constructions are perpendicular to the direction of propagation of longitudinal waves. The angles of incidence in the planes of cracks within the walls of constructions with approach/approximation to epicenter umen'shayutsya and in the region of epicenter become parallel to the earth's surface.

Horizontal cracks in walls are arranged largely under windows or near the base of buildings, thinner above windows, lower than garret overlaps. By restoring perpendiculars to the planes of cracks is made

the attempt at least roughly to evaluate the depth of the occurrence of the gipotsentra of earthquake. It proved tc be order 5-7 km that it will agree well with instrument/tocl data.

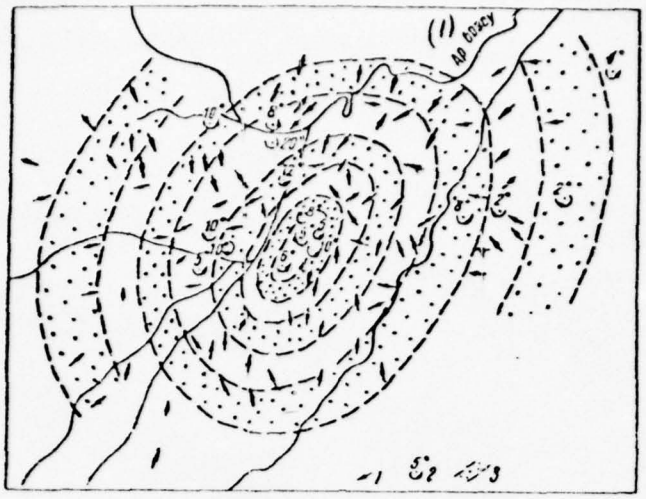

Fig. 93. Diagram of an incidence/drop in the ducts and others the vetikal'no of the objects corfronting in time of the basic jerk/impulse of Tashkent earthquake. 1 - the incident direction in the over ducts, columns, antennas and, etc; 2 - angles and the direction of the rotations of stones, memorials and, etc; 3 - the zone comparatively of the bol'shnkh of failures.

Key: (1). Are. to bozsu.

In the walls, arrange/located along the direction of propagation of seismic waves, are formed oblique cracks, whereupon one of the cracks hardly is noticeable. It is clear the fiksiruyetsyatreshchina, arrange/located perpendicularly to the propagation of seismic ray/beam.

But if the walls are aligned across the propagation of seismic waves, then in them also are formed X-shaped, equally wide cracks. These walls are destroyed more powerfully, and in many instances they crumble.

As a result of numerous iterative impulses, occurred the restoration previously placed cracks.

The incident direction in the object/subjects, oven ducts, antennas and other vertical columnar constructions has the determined regularity. In the majority of cases, these object/subjects fall towards the direction of seismic ray/beam, i.e., to the side of epicenter. On the basis of the analysis of an incidence/drop in the ducts and other vertical constructions, is comprised the map/chart, which makes it possible to localize the epicentral zone of Tashkent earthquake (Fig. 93).

In the failure of chimney stacks and buildings, also is detected the regularity. The relatively greatest failure of chimney stacks and buildings form concentric bands from 300-400 m wide of epicenter, increase to 1000 m on the boundary of pleystoseystovoy range. Bands

in plan/layout delineate oval with the long axis of northeast strike/course. Band edges to a certain extent are carried out conditionally and tentatively. Finally this phenomenon is not explained; however, is not excluded the possibility of the appearance of such anomalous zones as a result of the formation/education of standing waves in the layer, which covers crystal basement.

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During Tashkent earthquake are noted also the rotations of different object/subjects, for example: memorials to Gogol on analogous/similar street, to Akhunbabaevu in the park/fleet im. S. Rahimov, to A. S. Pushkin on Puskinskaya area, the cylindrical brick duct of the boiler room of the palace of art by height 20 m, the columns of barrier in the court of the Ministry/department of foreign affairs of the Uzb.SSR. Chimney stacks in the region of Beshagach, working town and other places turned themselves around axis to angle from 5 to 15°. In this case, the maximum angle of rotation is noted in epicentral zone and decreases during removal/distance from it.

Household articles (furniture, ovens, coolers), and also machine tools, school desks the, etc also of ispytyali vertical motions.

The wide acceptance of cracks was observed on the surface of the Earth, in buildings and constructions in the band of development, was loess and loess formation/education. In the pebble deposits of basin

r of Chirchik, the crack formation virtually is absent. This, apparently, one should consider with seismic city planning and further building-up of city.

Vertical motions of the earth's surface in a EPITsENTRAL'NOy zone along data of geodetic measurements.

At present one of the basic methods of obtaining the quantitative characteristics of the vertical tectonic motions of the earth's surface (both rapid seismic and slow, secular) is the method of repeated repeated leveling. Special importance this method acquires during the study of tectonic motions in the seysmoaktivnykh regions where the local vertical displacements of the earth's surface, caused by deep processes in the earth's crust, can achieve considerable size/dimensions.

However, the comparison of the results of two levelings gives the only averaged value of the relative shifts of the surface layers of the earth's crust and the average speed of these movements for time interval between the first and second levelings.

For obtaining reliable results, the leveling is fulfilled with the maximum accuracy in program I and II classes. During contemporary leveling I and II classes are applied precision levels with flat/plane-parallel plate and Invar racks. The courses of leveling are laid in direct/straight and opposite directions. During leveling

I class in the direct/straight and back stroke of observation, they are carried out according to two pairs of racks (left and right courses), while during leveling II class are carried out according to one vapor. The accuracy of leveling I class is characterized by the root-mean-square error ± 0.5 mm on 1 km course, and II class - ± 1 mm on 1 km course. Leveling lines are secured in locality by the special signs: fundamental, ground and wall reference points.

The study of vertical tectonic motions in Tashkent is initiated immediately after earthquake with the specialists of the state geodetic service. On area 390 km^2, is provelirovano more than 400 km according to the program of II class. The lines of repeated leveling are laid on the routes of leveling II class, produced into 1962-1965. In this case, are repeated determined the heights of 313 leveling signs.

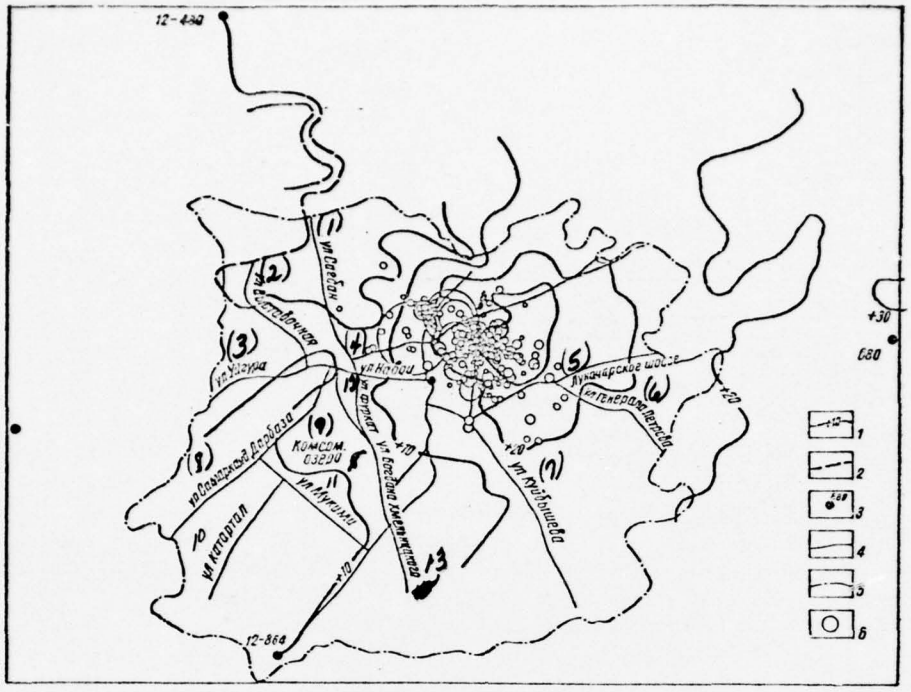


Fig. 94. Map/chart of the relative vertical motions of the earth's surface in the territory of Tashkent (leveling 1962-1965 and 1966). 1 - the line of equal changes in altitude; 2 - the same, assumed to be; 3 - leveling sign (reference point), its number and a change in altitude; 4 - street; 5 - the boundary of city; 6 - the epicenters of earthquakes.

Key: (1) st. of Saglan. (2) is exhibitior. (3) st. of uigur. (4) st. of Naboi. (5). Lunatsarskog illegible. (6) st. illegible. (7) st. of Kuibyshev. (8) st. illegible Lartaza. (9). Komsom. lake. (10) st. of katartal. (11) st. Mukimi. (12) st. Furkat. (13) st. of the bogdama khmel'ntsdkogc.

In order to obtain the more reliable data on vertical motions, the lines of repeated leveling are laid far beyond the limits of city. In northwestern direction the leveling is executed to the station of Dzhilga (50 km of city) along the line of leveling I class, laid into 1963-1964. In south-west direction - also along the line of leveling I class - to the populated area Buttermilk (45 km of city).

As a result of the comparison of data of leveling 1966 and 1963-1964, established/installed that groundvvy reference point 12-480, arrange/located about the station of Keles, did not change its position by height. In addition to this, the analysis of the results of leveling 1963-1964, 1941-1944, executed of line Arys6-Tashkent, also indicates the invariability by height of the region of the location of ground reference point 12-480 relative to the station of Arys'.

During the treatment of the materials of leveling, the extents of vertical movements are calculated relative to this reference point whose position is accepted by conditionally constant/invariable.

The presence in Tashkent of the vast leveling grid/network, created to earthquake, made it possible to produce the comparison of the results of leveling 1966 and 1962-1965 and to compose the map/chart of the relative vertical motions of the earth's surface (Fig. 94). For an image on the map/chart of the zones of uplift/rise and depression, are used the lines of equal charges in altitude of the points of the earth's surface.

In city are separate/liberated the regions with the different character of vertical motions. Almost entire investigated territoripreterpela is relative uplift/rise.

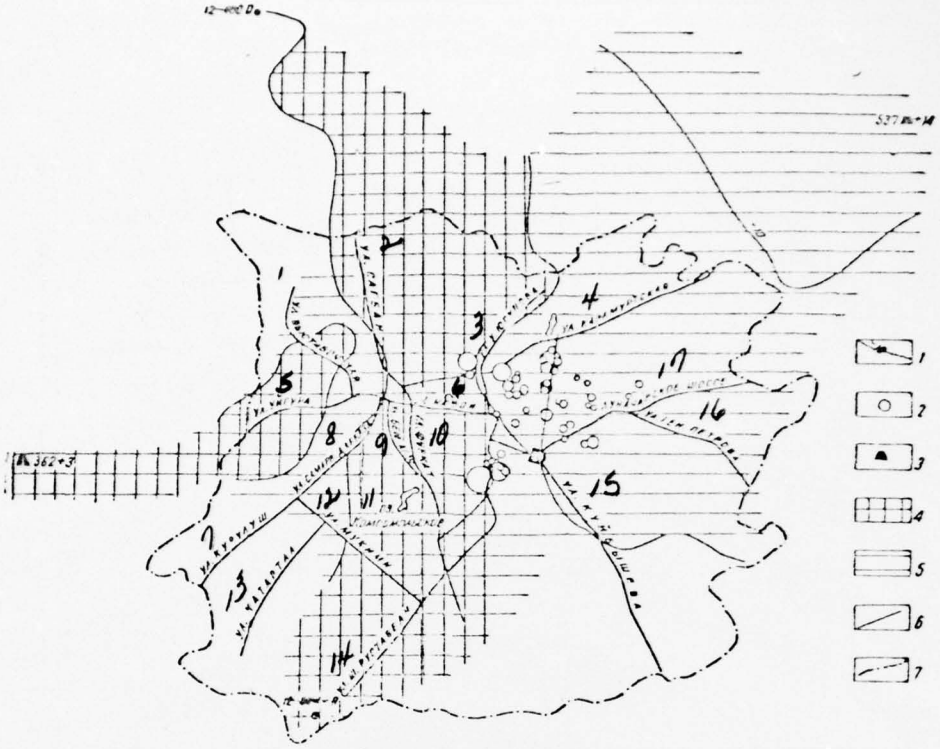


Fig. 95. Map/chart of the relative vertical motions of the earth's surface in the territory of Tashkent (leveling 1966-1967). 1 - the line of equal changes in altitude; 2 - the epicenters of earthquakes; 3 - leveling sign, its number and a change in altitude; 4 - the zone of uplift/rise to 10 mm; 5 - the zone of depression to 15 mm; 6 - street; 7 - the boundary of city.

Key: (1) st. illegible. (2) st. of saglan. (3) illegible. (4) st. illegible. (5) st. of uygurl. (6) nlvcn. (7) st. of kugchlush. (8) st. samark. illegible. (9) illegible. (10) st. fchrkat. (11) Kcmscmca'skcye. (12) st. of mukimn. (13) st. of katartaa. (14) illegible. (15) st. of kuybysheva. (16) st. by Petrov's fact. (17) lunatsarskoye highway.

Most intensely it was revealed in the region of central seismic station "Tashkent", where the value of vertical displacement turned out to be close to +40 mm. In the eastern neighborhoods of Tashkent, 2.5 km the to the south populated area of Durmen', is fixed the uplift/rise of the earth's surface on 30 mm. The south-west part of the city underwent relative uplift/rise more than on 10 mm. At the same time, in the northwestern part of the city, in the region, limited by the ditchhes of Zaur and Maykurgan, established/installed the relative depression of the earth's surface to value on the order of 15 mm.

The geodetic works in Tashkent, executed in 1966 after earthquake, were only the beginning of systematic research on the contemporary motions of the earth's crust in one of the seismic regions of the Soviet Union.

During 1967 continued research on the vertical motions of the earth's crust. Executed repeated leveling I and II classes. By the distinctive special feature/peculiarity of these works is the purposeful directionality, the large saturation of leveling grid/network fundamental and ground reference points and the higher accuracy of measurements.

Leveling I and II classes 1967 reveal/detect/exposeed the strain of the earth's surface during period of 1966-1967 (Fig. 95). The eastern part of the city was drop/omitted. A decrease in the heights of leveling signs occurs in direction from south to north and it

reaches the maximum value (15 mm) in the region of the settlement of Kadyr'ya.

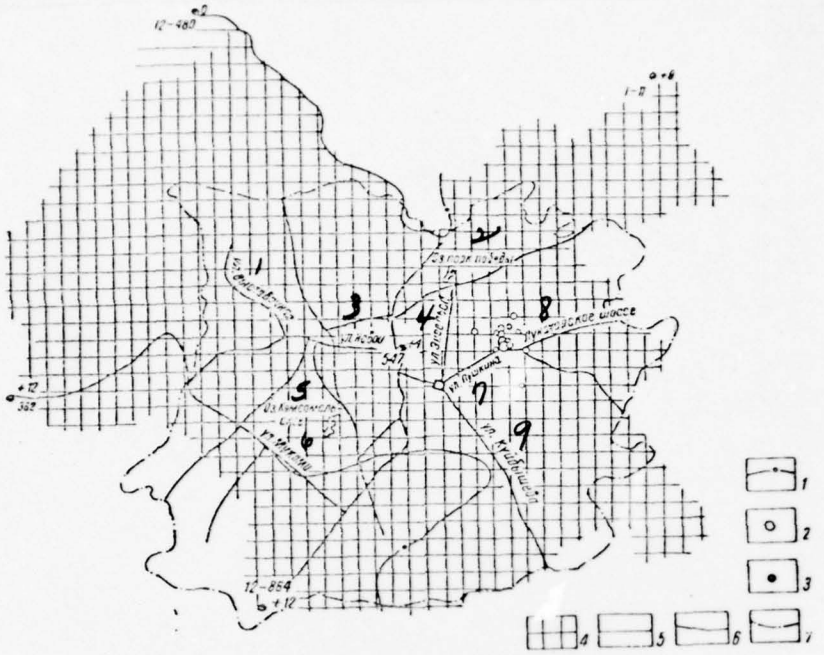
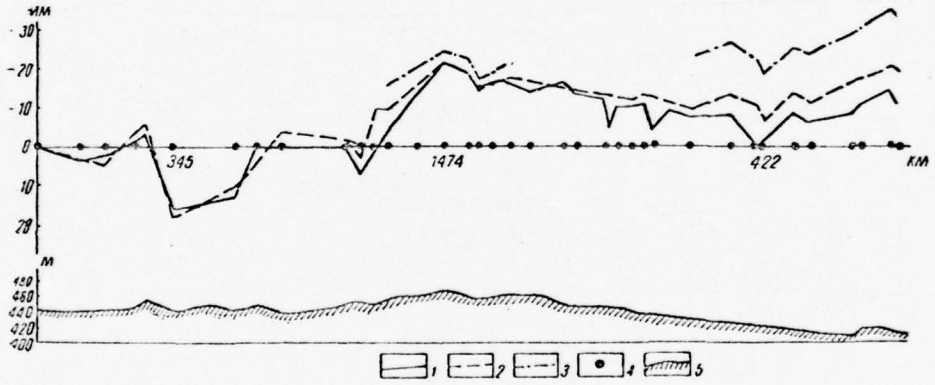


Fig 96. Map/chart of the relative vertical motions of the earth's surface in the territory of Tashkent (leveling 1967-1968). 1 - the line of equal changes in altitude; 2 - the epicenters of earthquakes; 3 - leveling sign (reference point); 4 - the zone of uplift/rise to 15 mm; 5 - the zone of depression to 5 mm; 6 - street; 7 - the boundary of city.

Key: (1) st. illegible. (2) Lake of the park of conquest. (3) st. of na'oi. (4) st. Eneyel'ss. (5) Oz. Komsomal'skoye. (6) st. Mukili. (7) st. Pushkind/ (8). Lundcharskoye highway. (9) st. Kuibyshev.

Fig. 97. Curve/graphs of a change in altitude of leveling signs in line gruntovyy reference point 14-480 - gruntovy * reper 12-864 (North-South). 1 - a change in altitude in data of leveling 1962-1965 and 1966; 1 - the same, in data of leveling 1962-1965 and 1967; 3 - the same, in data of leveling 1962-1965 and 1968; 4 - leveling sign (reference point); 5 - topographic profile.



In the south-west part of the city, is noted the uplift/rise to 10 mm.

Geodetic works in Tashkent are continued in 1968 (Fig. 96). Uplift/rises to 10 mm and more during pericd of 1967-1968 are noted on the larger part of the city.

According to data of tekhkratncgc repeated leveling 1966, 1967 and 1968 on the western and scuth-west cutskirts of Tashkent, distirctly exhibited the continucus uplift/rise.

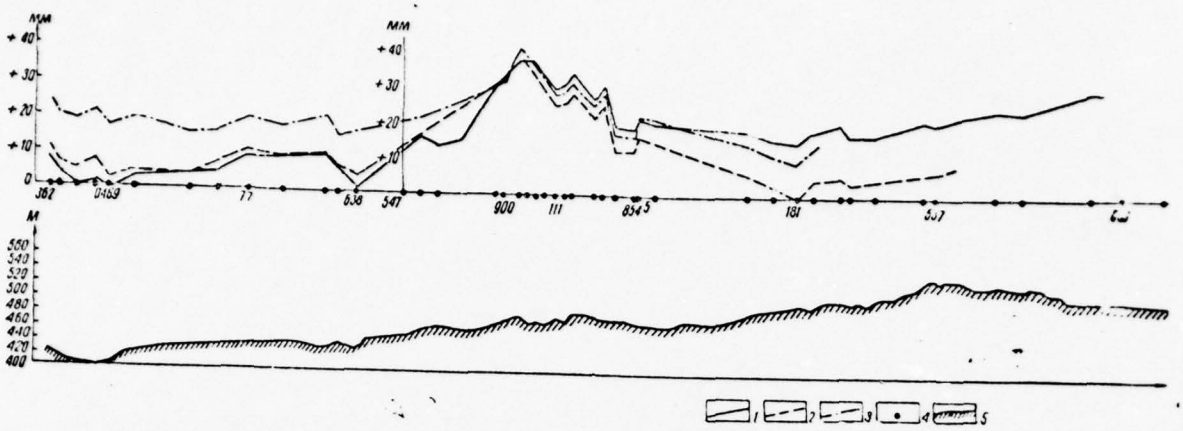


Fig. 98. The curve/graphs of a change in altitude of leveling signs in line fundamental reference point 362 is fundamental reference point 680 (west-east). 1 - a change in altitude in data of leveling 1962-1965 and 1966; 2 - the same, in data of leveling 1962-1965 and 1967; 3 - the same, in data of leveling 1962-1965 and 1968; 4 - leveling sign (reference point); 5 - topographic profile.

On the remaining part of the city, is observed the alternation of the directionality of vertical motions.

It is characteristic that the epicenters of earthquakes, according to data by TSS "Tashkent", are arranged in the zones of increased gradients (1967-1968) of the vertical motions of the earth's surface.

For the more demonstrative illustration of the character of vetikal'nykh motions, are made the curve/graphs of a change in altitude, constructed according to data of leveling 1962-1965, 1966, 1967 and 1968 (Figs. 97, 98). On these figures are depicted the topographic profiles, constructed according to the lines of repeated leveling.

For judging about vertical motions in the territory of Tashkent for more prolonged period, are compared data of levelings 1894-1907, 1941-1944 and 1963-1964, executed vdol'zheleznoy road. In this case, established/installed that the region of Tashkent is risen relative to the station of Arys' (150 km the north of Tashkent) at the average speed, approximately equal to 1.4 mm/year. It is here necessary again to emphasize that the question is not absolute, but about relative speed with respect to the station of Arys'.

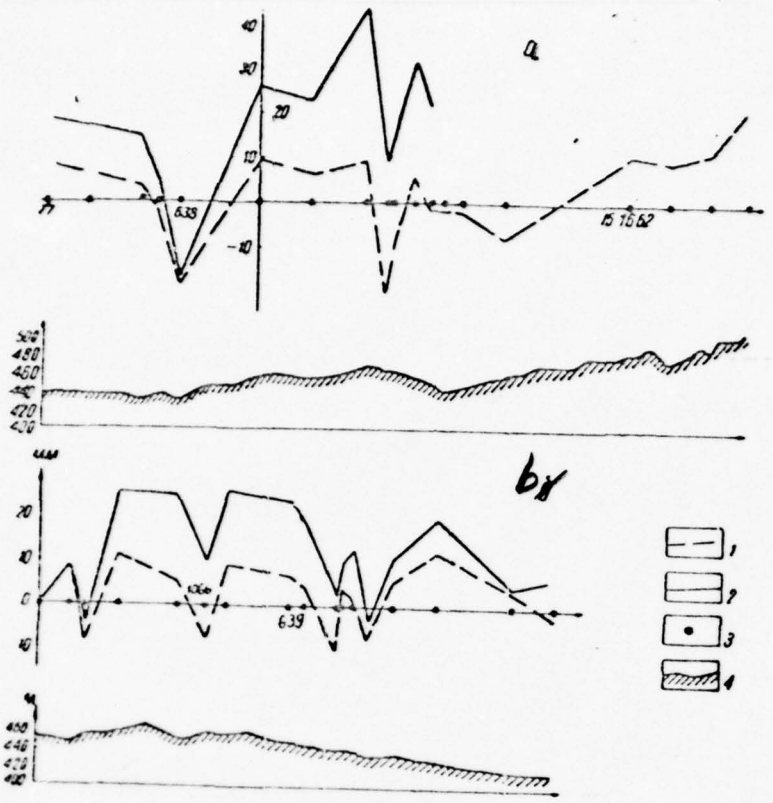


Fig. 99. The curve/graphs of a change in altitude of leveling signs in lines wall reference point 1084 is wall reference point 406 (North-South) and wall yeper 77 is wall reference point 590 (west-east). 1 - a change in altitude, in data of leveling 1939-1940 and 1962-1965; 2 - the same, in data of leveling 1939-1940 Jan. 1966; 3 - leveling sign (reference point); 4 - topographic profile.

During the comparison of the nivelirovaiy, executed in Tashkent to earthquake into earthquakes into 1939-1940 and 1962-1965, with leveling 1966 are revealed the general tendency of the development of contemporary motions and their differentiated character (Fig. 99).

The results of investigations given above show that the contemporary motions of the earth's surface in Tashkent seismic active region, as a rule, have the same directionality, as neotectonic motions. This is confirmed by geomorphological investigations.

Before geodesists will be worth important problem - systematically following the behavior of the earth's surface in Tashkent seismic zone, reveal/detecting the laws governing the motions which will aid subsequently to solve the problem of forecasting earthquakes. In Tashkert and beyond its limits yearly will be fulfilled high-precision geodetic measurements for the development/detection not only of the vertical, but also horizontal motions of the earth's surface.

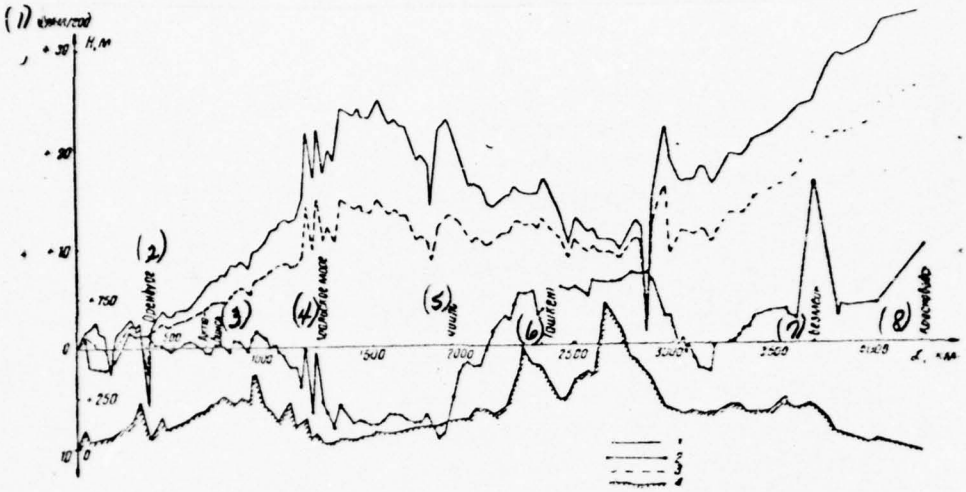


Fig. 100. Curve/graphs of a change in the speeds of the relative vertical motions of the earth's surface on route Kinel6-Krasnovodsk. 1 - speed change, in data of leveling 1894-1910 and 1943; 2 - the same, in data of leveling 1943 and 1055-1964; 3 - the same, in data of leveling 1894-1910 and 1955-1964; 4 - the profile of route.

Key: (1) mm/year. (2). Orenburg. (3) is Aktyubinsk. (4). Aral'skoye more. (5) Chiim. (6). Tashkent. (7). Bezmsig. (8) illegible.

REPEATED LEVELING ON LINE KINEL6-TASHKENT-KRASNOVODSK.

The line of repeated leveling Kinel' - Tashkent - Chardzhou - Krasnovodsk begins on the eastern outskirts of the Russian platform, it intersects several structural-tektoniceskix zones and concludes on the shore of Caspian Sea. Its general length is somewhat more than 4200 km.

The first levelled works on this line were initiated in 1894 for the precision determination of the height of Tashkent observatory relative to the level of black sea. By means of leveling line Krasnovodsk-Tashkent, the transmission of height by the water leveling through Caspian Sea, ther leveling on the lines of the Caucasus the Tashkent high-altitude mark of observatory was connected with the level of black sea. Works on line Krasnovodsk-Tashkent ended in 1900.

In 1904 is bygone is placed the problem to connect the lines of leveling Sresney Asia and Russia by means of the prolozheniya of line Tashkert-Orenburg. Leveling continued from 1904 on 1910.

Of the section of line kinel6-Orenburg of approximately 350 km long the first leveling produced in 1887. In all on this line it is laid by 164 steppe brands. The average distance between signs of approximately 25 km. It was preserved at present 125 brands, more than or less evenly arrange/located or line. Second leveling entire

line is executed in the years of the Great Patrictic War, the third is executed into 1955-1964 accerding tc the prcgram cf contemporary leveling I class.

During the investigatien of all three levelings, established/installed that the least precise results are obtained during the first leveling. Leveling 1894-1910 was performed in direct/straight and oppcsite directions, as a rule, in different years, by the different cbservers, the instruments and racks. All this ccrsiderably lowered the accuracy cf measurements.

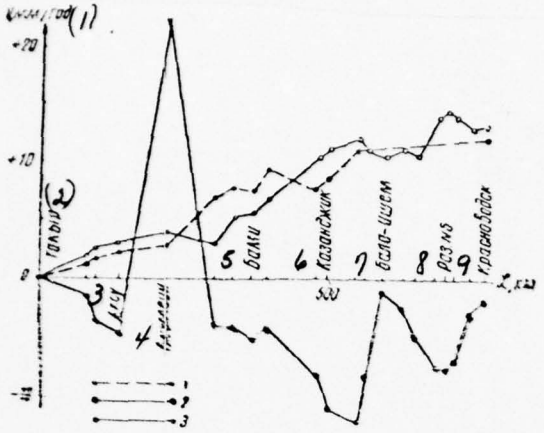


Fig. 101. Curve/graph of a change in the speeds of the relative vertical motions of the earth's surface along the route of Takir (Tedzhen) - Krasnovodsk for period from 1895 along 1962. 1 - speed change in data of leveling 1895-1943; 2 - the same, in data of leveling 1943-1952; 3 - the same, in data of leveling 1952-1962. Key: (1) mm/year. (2). Takyr. (3) illegible. (4) illegible. (5) by tami. (6). Kazandzhik. (7) Bale-ishem. (8). Razib. (9). Krasnovodsk.

Ic deficiency/lacks in the first leveling, cre should also relate tcc rare an attachment of lire by leveling signs (cr the average through 25 km).

The quality of the seccnd and the especially third levelings a good second leveling satisfies the requirements fcr contemporary leveling II class.

As a result of the comparison cf all levelings, is comprised the curve/graph of the speeds cf the vertical mcticns cf the earth's surface (Fig. 100). From curve/graph it is evident that the vertical mcticns of the earth's surface on the incivicual sections of lire irtc different years had different speed and directicrality. Are especially great differences cn sectiens the stage of Martuk - the stage cf Kamyshly-Bash (757 km) and of the stages of Chiili - stage sands (1289 km).

Cn sections the stage cf Kinel' - the stage cf Martuk (570 km), the stage of Kamyshly-Bash - the stage cf Chiili (569 km) and of stages sands - stage Krasnovodsk (1066 km) mctien they had ccrstant character.

According to the results of all levelings, Krasnovodsk is risen relative to Kineli at considerable speed, but the speed of uplift/rise is different: in the period between the first and second levelings, it reached 33 mm/year, in the period between the second and third - it decreased tc 10 mm/year. Such large differences in the speeds cf

mctions in the different periods of time on some sections and on entire line force to be related the findings with large precaution. Very probably that some of these data are distorted by the large errors of leveling.

The approximate value of the absolute velocity of depression in the region of Kineli can be estimated by value 6 mm/year for period of 1920-1960 (gorelov, Matskova, 1965). In the region of Krasnovodsk the approximate value of the absolute velocity of motion it is possible to find, using the results of urovnemernykh observations (they are performed from 1915) and water leveling relative to p. makhachkala where the absolute velocity of motions is somewhat less than 1 mm/year.

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The corresponding calculations show that the approximate value of the absolute uplift/rise of land in Krasnovodsk can be estimated for period of 1915-1944 by value 1 mm/year, for period of 1944-1966 estimated 5 mm/year.

Thus, for the period between the second and third levelings the velocity of the uplift/rise of Krasnovodsk relative to Kineli, obtained from data of repeated leveling, coincides with the velocity, determined according to urovremennym data. For a period between the first and second levelings they sharply are distinguished. Therefore

we are inclined to consider that the velocity of motions, obtained from the comparison of the results of the second (1939-1944) and third (1955-1964) levelings, as a whole for entire line is more reliable than obtained from data of the first and second or first and third levelings. It is possible that on the individual sections of line the results of the first leveling also are sufficiently reliable and can be accepted into consideration. Unfortunately, that have material' do not make it possible to concrete/specific/actually indicate such sections.

On sections Krasnovodsk - stage the Tedzher is executed four leveling. On this section in 1952, i.e., after earthquakes 1948 (ashkhabad and Kazandzhik), executed supplementary leveling (Fig. 101). All velocities are considerably greater than the possible errors of their determination. Will agree well between themselves the values of velocities during the first and third periods when near the route not of bygone powerful earthquakes.

The velocity of motions in period from 1943 on 1952 considerably differs from the average speed for always (1895-1962). Specifically, during this period near route, occurred large earthquakes.

By collating data of repeated leveling with the arrangement/permutation of the epicenters of earthquakes, it is possible to draw the conclusion that during earthquakes in the regions of the location of epicenters occurred ar abrupt change in the

directicnality of vertical mcticns. The mcticns of separate/individual block/mcdule/units at this time had different sigrs and value. During earthquakes in these zcres, occurred the mctions of the earth's surface whcse speed ccnsiderably exceeded the "ncrmal" speed of contempcrary mcticns in the appropriate zones.

RESULTS CF NAKLONOMERNYKh CESERVATICNS IN TASHKENT IN THE PERIOD CF ITERATIVE IMPULSES.

The assumption that the mode/ccnditions of the contempcrary tectonic moticns of the earth's crust befcre earthquakes is characterized by the determined special feature/peculiarities, is supported by many specialists.

The repeated levelings, carried out in the different parts cf terrestial glcbe in the territcries where the vpcsledstviye occurred pcwerful earthquakes, attest to the fact that fcr certain time tc earthquake (usually calculated by decades) the speed of the mctien of the earth's surface substantially is changed, increasing or decreasing (Meshcheryakov, 1968). Is pcssible even a change in the sign of mctien. In this sense repeated levelings in earthquake-hazard regicns can be related to the number cf methods cf lcng-term forecasting earthquakes.

The considerable strains of the earth's surface were observed directly before earthquakes. In Japan after several hours to scme

powerful earthquakes (M = 6.6-7.5) are noticed the uplift/rises of the earth's surface to 1-2 m (Khagivara, 1968). Are known also the facts, unfortunately been few in number, the anomalous course of the slope/inclinations of the earth's surface before earthquakes.

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Thus, not only the considerations of hypothetical character, but also direct/straight experimental data testify to the peculiarity of slow movements before earthquakes.

The attempts to utilize special feature/peculiarities in the course of terrestrial slope/inclinations for the forecast/prediction of earthquakes are undertaken at the very beginning of instrument/tool seismological observations in Uzbekistan.

First managing by seismic station "Tashkent" G. V. Popov and managing by seismic station "Samarkand" M. E. Repnikov utilized for recording the contemporary motions of the earth's crust the designed by them horizontal pendulum-inclinometers (Popov, 1940, Repnikov, 1940). However, the low technical capabilities of these instruments and the inadequacy of the procedure for observations did not make it possible to obtain positive results. The observations of recent years showed that the slope/inclinations, foreshocks, are very small and for their development/detection is necessary the application/use of highly sensitive instruments, placed into the underground chambers for an

insulation from external agencies.

In 1964-1966 research on tectonic strains with the aid of inclinometers, she was conducted by V. N. Yakovlev under the guidance of the Doctors of Physics and Mathematics A. Ye. Ostrovskiy in the eastern part of the Ferganskoy valley (Yakovlev, Bagmet 1966). As a result established/installed that with the instruments of the construction of A. Ye. Ostrovskiy it is possible to measure with high accuracy the very small deformations of the earth's surface.

Unfortunately, for a number of reasons nakloномernye observations in Tashkent are initiated on 30 April 1966, i.e., already after the occurred earthquake. They pursued two target/purposes.

1. Determination of special feature/peculiarities in the course of the slope/inclinations of the earth's surface in the period of the iterative impulses of Tashkent earthquake.

2. Research on the slow deformations of the earth's surface as consequences of the occurred powerful earthquake.

Recording slope/inclinations was conducted by A. Ye. Ostrovskiy's inclinometers at the removal/distance several hundreds of meters from central seismic station "Tashkent". Initially instruments were placed in basement 4 m deep, then were transferred into basement 10 m deep. Both these chambers not of prisposobleny for observations with

inclinometers, in consequence of which the notation of inclinometers strongly it was distorted by different interferences.

Extremely it complicated observations and that circumstance that the powerful iterative impulses broke the pendulums of inclinometers. For the restoration/reduction of instruments and relative stabilization after this temperature conditions in the chamber, was required the specific time, so that to obtain continuous notation it was possible only after the curtailment of powerful aftershocks.

During the specially organized naklonomernykh observations are recorded in essence the tidal slope/inclinations, which are superimposed on the so-called zero drift of pendulum. The slope/inclinations, caused by other reasons, compose in the total slope/inclination insignificant portion/fraction. In Tashkent in connection with the unfavorable conditions of observations the notation of slope/inclinations turned out to be very complex (Fig. 102). Residual slope/inclination after removal/taking boss/inflow is correlated well with changes in the external temperature. Temperature effect is so great that in the summer period when the daily range of temperature greatest, temperature slope/inclinations in value exceed tidal.

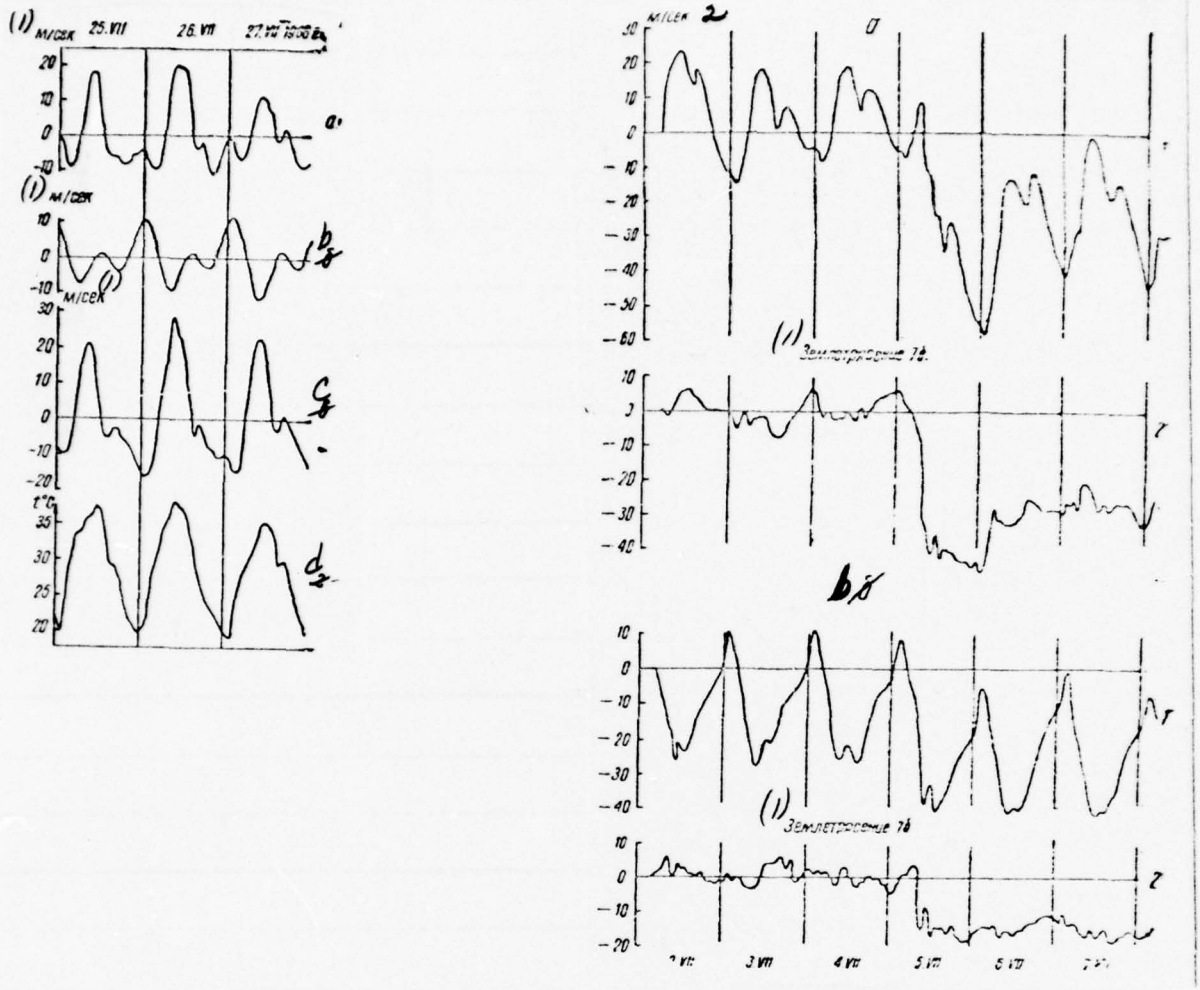

Fig. 102. Comparison of the slope/inclinations of the earth's surface with external temperature. a) the observed slope/inclination; b) the calculated boss/inflow; c) slope/inclination with the removed boss/inflow; d) temperature.

Key: (1) m/s.

Fig. 103. Curve/graphs of the slope/inclinations of the earth's surface in the azimuth of V-Z (a) and in the azimuth of S-N (b) before

and after the earthquake on 4 July 1966. 1 - slope/inclination with the removed drift and boss/inflow; 2 - residual slope/inclination after the exception/elimination of temperature component.

Key: (1). Earthquake. (2) m/s.

Temperature slope/inclinations do not yield to a precise quantitative account. At the same time to rote against their background insignificant special feature/peculiarities in the course of slope/inclinations, the connected with preparation earthquakes, is impossible. For the release of notation from temperature component, is used the following method.

After noting that during several days the amplitude and the character of the manifestation of temperature slope/inclinations are changed within small limits, it was computed a daily mean slope deviation for a small time interval (tidal slope/inclinations from the total notation preliminarily were eliminated). In average did not enter the days during which it occurred jerk/impulse, or days before and after earthquake. The obtained thus averaged slope/inclination sufficiently accurately reflects the common/general/total laws governing the course of temperature slope/inclination.

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The residual slope/inclination after removal/taking temperature contains the "random" slope/inclinations, caused by measuring errors, neisklyuchennuyu part of the temperature slope/inclinations and the anomalous slope/inclinations, caused by these or other reasons, including connected with earthquakes.

Figure 103 gives the notations of the slope/inclinations of the earth's surface before and after iterative impulse 4 July 1966 with k

= II, that was being perceived in epicenter with the force of 7 balls.

The background of residual slope/inclinations by the azimuth of S-N does not exceed 5 m/s of arc relative to the middle level. In the azimuth of V-Z the background somewhat above reaches 7-8 m/s of arc. In the extent/elongation of two days to jerk/impulse, any determined special feature/peculiarities in the course of slope/inclination, which anticipate jerk/impulse and which exceed background noise level, are not noted.

The absence of the perceptible deformations - the forerunners of aftershock does not seem those which were not expected. according to the available concepts about the characteristic of the discontinuities, which cause iterative impulses, the disturbance of the continuity of rock/species in the focus ranges of aftershocks, apparently, it is not anticipated how much-or by noticeable deformations, i.e., in origin/hearth occurs brittle discontinuity.

On both components approximately in 17 hours after earthquake is detected a noticeable change in the course of slope/inclinations. Any sharp oscillations meteorological factors during this period are not noted. It is not bygone also other explicit reasons, which are powerful to cause the disturbance of the course of slope/inclinations. It remains to assume that the anomalous behavior of slope/inclination is connected with the aftereffect of earthquake.

The motion of the earth's surface in the region of observation station caused slope/incliration with the azimuth of approximately 290°, which coincides with direction in epicenter. The mechanism of shift in origin/hearth with this jerk/impulse is analogous to the mechanism of the basic earthquake. During similar displacement of rock/species taking into account the radiation pattern of deformations (see Fig. 25) the greatest vertical displacement on the surface of the Earth must be observed to the east-south-east from epicenter and in this case have positive sign. This distribution of the displacement of the earth's surface must cause the slope/inclination at observation point, directed to the side of epicenter. On the basis of the value of slope/inclination, the maximum lift of surface composes the fractions of millimeter.

With hypocentral distance 5000 m and the propagation time of 17 hours, the velocity of plastic wave, caused by deformations in seismic center, composes primerno 300 m/h.

Thus, naklonomernye observations, apparently, confirm the concepts about the brittle discontinuities, which cause iterative impulses, testifying to the absence of the previous deformations of the surface of the Earth. At the same time of deformation - the consequence of iterative impulses - they have a value, sufficient for a fixing as inclinometers.

For the determination of the possible special

feature/peculiarities of the motion of the earth's surface, which are exhibited long before to aftershocks, are constructed the vector diagrams of slope/inclinations (Fig. 104). From the middle of September 1966 during two months, the course of slope/inclinations is sufficiently calm and reflects the common/general/total tendency of movement for this period. The fractures of diagram and short-term changes in the common/general/total direction of motion, apparently, are explained by the effect of the purely external reasons, connected with the unfavorable conditions of observations.

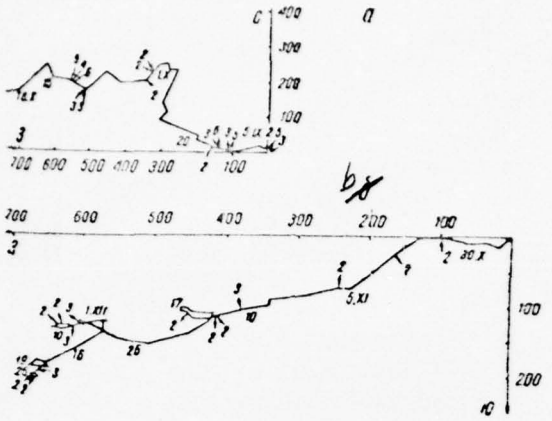

Fig. 104. The vector diagrams of the slope/inclinations of the earth's surface with 4.IX of 18.X 1966 (a) and with 27.X of 28.XII 1966 (b) (by rifleman/gunners are noted the torque/moments of earthquake, numeral of arrow/pointer - earthquake intensity in balls).

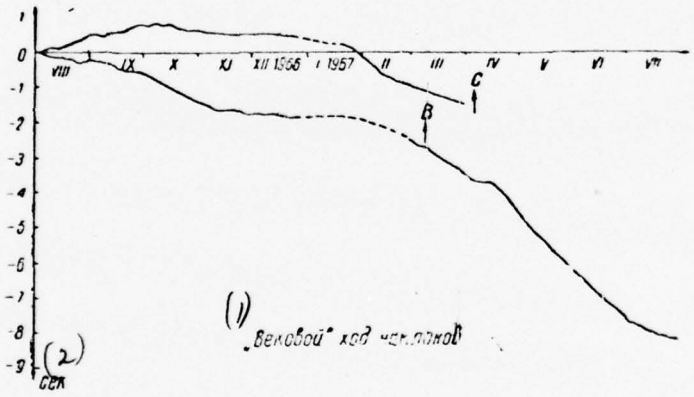

Fig. 105. Course of the slope/inclinations of the earth's surface from August 1966 through July 1967, constructed according to daily mean values.

Key: (1) the "secular" course of slope/inclinations. (2) s.

The vector diagrams for the second half of November and December 1966 are characterized by the large number of loops (the "storms of slope/inclinations". about to V. F. Borchkovskiy). Correlation between disturbance/perturbations in the course of slope/inclinations and the manifestations of seismicity is not observed. The "storms of slope/inclinations" are not accompanied by earthquakes, and vice versa, earthquakes occur at moments with respect to the quiet run of slope/inclinations.

Loops on vector diagram are formed in period when they are noted very small slope/inclinations, by virtue of which their direction is unstable. Under the effect even of insignificant extraneous effect, diurnal slope/inclination can acquire any direction. The appearance of loops on vector diagram is explained, probably, by precisely this reason and does not have communication/connection with earthquakes.

The course of slow slope/inclinations in both components differs from the linyrogo, which reflects, apparently, the annual variations in the slope/inclinations of the earth's surface, caused by seasonal changes in the meteorological factors (Fig. 105).

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The value of the "secular" course of slope/inclination in the azimuth of V-Z is approximately 8 seconds per annum. The direction of slope/inclination is western. The value and the direction of slope/inclination in the component of S-B due to incompleteness annual

cycle are not determined. It is possible to only say that in period from August 1966 through March 1967 slope/inclination in the azimuth of S-N is less than in the azimuth of V-Z.

During the comparison of the findings on the surface slopes of the Earth with the results of levelings, were utilized the geodetic observations, made during July-November 1966 and during June-October 1967, which covered the same time interval, as nakloncmernye observations.

To scale of an entire area g. of Tashkent for the indicated period local uplift/rises and depressions, are not fixed. The line of zero excesses has meridional direction, it passes approximately through the observation station and divides the territory of Tashkent into 2 parts: western, all point/items of which have positive excesses, and eastern with negative excesses, i.e., the territory of Tashkent experience/tests common/general/total slope/inclination to the east. In meridional direction the slope/inclination is absent.

Appears the contradiction between reading the wide component of inclinometers and geodetic data. However, this contradiction seeming is caused by the comparison of raznomasshtabnykh values. In the examination of the section of the profile of small extent, passing through the observation station, it turned out that the surface of the Earth in its neighborhood experience/tests slope/inclination for west. This it indicates the agreement of the results of the

measurement of the deformations of the earth's surface by two independent methods.

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Chapter of V

Phercmena, which accompany earthquakes and the problem of ~~forecast~~/prediction.

Light and electrical phercmena, which accompany earthquakes.

Despite the fact that the light phercmena are noted almost during all without exception/elimiratich pcwerful earthquakes, the nature cf brightress, until ncw, is not studied. The explanation of the reascn for this phencmenon by sparking cn electric power lines is not substantiated. On light phercmena during pcwerful earthquakes, it was communicated lcng before tc the ispcl'zcvanaiya cf electricity (Mallet, 1862). Such report/communicatcns enter from the ncuntain and sparsely pcpulated regicns where either cenerally there are nc electric power lines cr are weak-current lead/ducts, incapable tc create the effect of abundant brightness. With is concealed by

circumstance we they clashed during the examination/inspection of the epitsentra'noy range of the Brichmullinskogo earthquake on 24 October 1959 (transactions of IMM the A.S. of the UzSSR, 1963), during which, on the stories of the local residents, glowed the slopes of the surrounding mountain ranges.

For the first time most in detail and systematically light phenomena are investigated Teradoy (Terada, 1931) during destructive zemletcyaseniya into Idzu in 1930, but researcher it does not make concrete/specific/actual conclusions.

The first information about the fact that "whole sky above the city glowed", have obtained we from rural inhabitants later 1.5-2 hours after the underground jerk/impulse when the attendant motor vehicle of central seismic station accomplished the riding round of injured/damaged part g. of Tashkent and its neighborhoods. On the stories of the eyewitnesses, "the glow of bygone whitish-pink color reminded the scattered light of lightning". Analogous report/communications entered from g. of Yargiyulya, arrange/located 30 km the south west of Tashkent. Thunderstorm phenomena neither in Tashkent nor in Pritashkentskom region during this period were observed.

This is how describes the phenomenon of brightness engineer A. P. Melnichuk, who lives on the street im. Bahimov's Sabira: "I heard from left side the powerful noise, recalling the work of motor,

immediately in the same side arose unusually the bright flash/burst white color, which during several seconds (4-5 s.) it grow/rose on brightress to taoy force, that for me it was necessary to cover eyes. Then occurred jerk/impulse, hardly not brought down me from feet. After jerk/impulse the world/light rapidly began to grow dim and together with its disappearance it ceased itself power supply".

By the witnesses of whitish-pink airglow above the city of tale many tashkenttsy, in that chisles the well-known scholars the specialists.

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Flash/burst "in the form of the scattered light of heat lightnings" observed on 26 April and on night from 9 on 10 May the Vice President of the Academy of Sciences of the Uzb.SSR academician S. V. Starodubtsev, who explained the possible reason for this phenomenon thus: "it is possible that here we deal with the avalanche-type disturbance of molecular bonds with discontinuity and monstrous friction of rocks".

The senior scientific worker of Central-Asiatic scientific research hydrometeorologic irstitute specialist in physics of the atmosphere of G. P. Lazarenko thus described its observations: "before the dawn on 26 April 1966 I awoke from terrible hum. After the window, which emerges on south, blazed the heat lightnings. Me it

seemed that these are unusual force thunderstorm" ....

The collaborator this same institute of F. V. Larionova, who lived in the very center of pleystoseystovoy range, proyenuvshis' from the underground jerk/impulse on 26 April, saw, that the room and the court of tale were illuminated "so, that in room as during magnesium flash/burst, it was possible to distirguish all object/subjects".

There are numerous report/communications about sparking the close, but clear each other electrical lead/ducts, the bluish brightress of the internal surface of the walls of the houses, which are periodically repeated heat lightnings.

To seismic station entered several report/communications about the spontaneous firing of flucrescent lamps shortly before underground jerk/impulses. This is how presented his observations engineer A. Tutaev, who lived during Tashkent earthquake on st. one-and-a-half (in the south part of the pleystoseystovoy range): "before the earthquake, on night from 25 on 26 April, to me was memorized this phenomenon. After awaking about 5 hours of the morning, I noted in shade the glowing luminescent tube envelopes".

Such phenomena observed the colleagues of the administration of cable and radio relay main lines, arrange/located on st. Navoi, in the certer of pleystoseystovoy range.

Here are their report/communications. "29. VI with 11 hours the mornings of lamp zazhglis' and after 15 min. after underground jerk/impulse they went out". "30. VI and 1 VII they glowed from the morring and went out in the hour or one and one-half after jerk/impulse". "2. VII - were not ignited, 4 VII - from the morning inflamed by full/total/complete heater two tubes even one by weak heater. They tried to include and to disccrrect/turn off. The lamps of rasli, then themselves were ignited. Ignitior occurred with the aid of starter - neon bulb". "They burred to 16 hours. The colleagues were situated in room to 19 hours 50 min., but lamp no longer they were fired. During powerful earthquake indoor no one it is bygone". "5. VII, when they arrived to work (9 hours 30 min.), lamps they burned. 12 Hours, they expired. After 5-10 min. again they inflamed, they blinked and they went out".

In the territory of central seismic station "Tashkent" for geoakusticheskikh observations during August 1966 is drilled half-kilometer blowhole. Upper 40 m are planted round by steel tube. The remaining part, presented by the deposits of stone loess deposits (marl), remained that which was uncased.

In blowhole on seven coaxial shielded with khlorvinilovoy insulation cables, are lowered and silted geoakusticheskiye receivers. At depth 500 m of surface, is arranged the basic large capsule, while at depths 300 and 100 m on one small kapsule.

The basic capsule is steel tube whose diameter is 10 cm. and whose length is 1 m. In it are placed: one vertically arranged/located geophone SPT-6 with internal electrical resistarce 300 ohm and three-component setting up of seismic survey receivers of the type of SP3D.

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The current-conducting line of geophone consists of two coaxial lead/ducts with the grounded within capsule screens. To each seismic receiver the SP3D is connected on one cable, and current transmission is realized on internal vein/strand and the shielding cover/braid. Free space in sonovnoy capsule, just as in two small, in which on coaxial cable are suspend/hung on one vertical seismic receiver of the type the "SP3D ", are filled by epoxy resin. Thus, is created reliable waterproofing srayada.

The coaxial cable on which is suspend/hung seysmopriyemnaya equipment by weight together with capsule 40 kg, is characterized by the following parameters.

The electrical resistance 1 km of cable with series-connected go conductor and cover/braid is not more than 30 ohm. The resistarce of polyethylene insulation (diameter 1.9 mm) between the central vein/strand and the screen at temperature of 20°C is 100 Ω/km.

The sectional area of the go conductor, which consists of 14 steel it lived by diameter 0.3 mm and 12 copper - by diameter 0.43 mm - 3 mm². Force to the discontinuity of cable is not more than 200 kg on 170 m construction length. Weight 1 km of cable - 122 kg. Disruptive voltage (frequency 50 Hz) with the duration of the effect 5 min. are not more than 2 kW. External insulation from polyvinyl.

Approximately through the week after the instrumentation of blowhole, on 7 September 1966 into 22-23 hours from local time, reveal/detected the intense runoff of electric charge from the external ends central it lived geophone. The specific crack of electrical discharge is bygone is audible at a distance 2-3 m of torchashchikh above the earth/ground ends of the cable. During the approach/approximation of lead/duct to eye/ear, Tresca's frequency increased and sonic effect it was transformed into continuous intense hissing. This phenomenon continued during 8-10 min. and then ceased itself. After 5 min. it arose again and after 2-3 min. again disappeared.

Analogous phenomenon was observed after 2 days, but bygone less prolongedly it perceived in the form of separate/individual cracks. With the measurement of the electrical resistance of cable, it turned out that its central veir/strand at depth of approximately 500 m was locked to the shielding cover/braid. Since cable lifting to the surface of the Earth is bygone practical is impossible, by the short-term feed of electrical voltage pulse 300 volts temporarily they

removed the closing/shorting of lead/ducts at half-kilometer depth.

However, through certain time again it followed by sample/test, observations of the runoff of the electric charge after this of tale were ended. We are solidly convinced in the fact that by the reason for breakdown is bygone the emergence of a large electric potential difference between the shielding cover/braid and the central habitable cable. Value of voltage 5-10 kW.

This is the only case when was possible to observe the appearance of a high electric charge.

Phenomena of atmospheric electricity, which precede earthquakes.

The large disturbance/perturbations of atmospheric-electrical field for 1.5-2 hours before the destructive earthquake are noticed for the first time by Ye. A. Chernyavskiy on 1 August 1924 in Dzhalal-Abade (Chernyavskiy, 1925).

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These aromalies were expressed in the intense fluctuations of electric intensity ir completely clear and calm weather the Kakiyelibo of the reason for meteorological origin under such corditions were excluded. Observations of electric field they conducted with the aid of the water-jet collector/receptacle, possessing the ability to instantly

answer changes of the electric field in atmosphere. As measuring meter is used listochkovyy electrometer.

Later some foreign authors (Schultetus, 1932) also expressed thought about possibility changes in the atmospheric electric field at the torque/moments, preceding or associating earthquakes.

In 1946 anomaly of electric field is recorded and in Tashkent before the Chatkal'skim earthquake (Chernyavskiy, 1955). Unlike observations 1924 in this case, the electric field was recorded by Benndorf's electrograph, and as sensor was applied the radicactive collector, possessing considerable inertness.

Before the earthquake on 4 March by 1949 Dushanbe V. M. Govorkov also noted the intense "disturbance/perturbations" of electrical field of the atmosphere (Chernyavskiy, 1955). In the same year Ye. A. Chernyavskiy noted the powerful "disturbance/perturbations" of the electric field before earthquakes in ch-garme. Such phenomena were noted after Chigarmskoge earthquake.

In the mentioned cases the good weather in which there are no reasons for the disturbance/perturbation of electric field in atmosphere, high value of earthquakes and nearness of their epicenters, observation by malcinertncy equipment - were favorable conditions for the detection of the characteristic anomalies of electrical field of the atmosphere, connected with earthquake.

Tashkent earthquake 1966, it is natural, it caused the interest in of this type to phenomena. Directed attention to recording electric intensity which already many years is conducted in Central-Asiatic scientific research hydrometeorologic institute for research on electrical field of the atmosphere. Observed data are inaccurate, as in the being applied equipment as sensor, is utilized radioactive collector - sufficiently inert, and as recorder - Benndorf's electrograph, capable of fixing only the average values of the strength of field for 1 min.

In the morning on 26 April 1966 in the territory of SANIGMI [sp? - Central Asian Scientific Research Hydrometeorological Institute] (next to OSS "Tashkent") is recorded the disturbance of electric field 5 hours to earthquake. These disturbances entail a change in the sense of the vector of electric intensity to the side, opposite by that that corresponds to normal field. True, on the eve of weather condition are bygone not by entirely calm, but during two-three hours directly before the earthquake of any meteorological reasons, which facilitate the disturbance of electric field, it was not observed. Is characteristic also the resemblance of the noted anomaly of electric field to the anomaly, fixed by the same equipment before earthquake 1946.

The anomalies of electric field preceded soprutstvovali to the separate/individual most powerful aftershokam, which followed after 26

April. Very frequently the special phenomena of atmospheric electricity were not observed.

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It is possible that the short-term, rapidly changing disturbance/perturbations of electric field occurred, but by this equipment, not fitted/not adapted/unadapted for such observations, they were not fixed.

If the observed anomalies are really/actually connected with tectonic processes at depths, then, apparently, any deep processes, which cause earthquakes, are accompanied by electrical phenomena. It remains not clear, which precisely deep processes cause electrical phenomena, in which communication/connection are located electrical effects and earthquake intersity, as affect effect the remoteness of epicenter, the depth of the seismic center and especially property of the rock/species in which occur tectonic processes.

At the same time one should consider that the electrical field of the atmosphere is caused by the electric charges of earth and by volume charges. If by the sole source of electrical field of the atmosphere is bygone the charge of earth, then the strength of this field of the surface of earth would be determined by the surface density of its charge - σ:

$$E = 4\pi\sigma.$$

But in connection with the presence in the atmosphere of space charges must be made to sshche Poisson's relaticrship:

$$div\, E = 4\pi\rho.$$

Then since in air space charges are distributed unevenly and are carried past observation point by airflow, electric intensity experience/tests vibration constant. In good weather these fluctuations are small, but in restless weather (cloud, the precipitation, the fog, the wind and, etc) they they can be considerable and the strength of field it can even accept opposite direction.

The component of electrical field of the atmosphere which is caused only by the charges of earth, and especially variation in this component as a result of deep processes with seismic phenomena, the fluctuations of electric field, caused by changes of the volume charges, they will prove to be in this case significant interferences. They can largely shade interesting us the disturbance/perturbations of electric field or even completely overlap them.

Therefore the method of the measurement of atmospheric electric field, although which made it possible under blagopriyatnykh conditions to reveal/detect seysmoelektricheskiye phenomena, is inconvenient with continuous tracking the electrical "pulse" of earth for the detection in it of the peculiarities associated with seismic

processes (Chernyavskiy, 1955).

Since up to now of ways to the solution of a similar problem it is not found, one should attempt to transfer field measurements from atmosphere directly into the Earth. Unlike the izmerenip of telluric currents, in this case must be measured potential differences, potential gradients or currents on the vertical line between the point in the upper layer of earth and the point or several points at those or other depths, reveal/detect/exposeed experimentally. The need the organizations of such observations indicate also the investigations, carried out by V. I. Ulomov with the colleagues of seysmostantsii "Tashkent". Virtually for this will be required the vertical blowhole through which for a contact with rock/species would be introduced the electrodes with the fixed to them and brought out outside cable, possessing high insulating properties and sufficient resistance by large pressure.

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By judging by the character of the observed disturbance/perturbations of electric field in atmosphere, from depths it is possible to expect the signals of both constant and alterrating voltages. Therefore for their recording must be applied the corresponding methods: galvanometric, oscillographic; possibly to nayde application/use pulse voltmeter. It is obvious, the introduction of such methods must be accompanied by extensive

experimental work both in the laboratory and under natural conditions.

It is possible to hope that thus the electrical "respiration" of earth and isolation against its background of the electrical anomalies, connected with the seismic phenomena of not distorted with atmospherics, will be studied.

EFFECT OF TASHKENT EARTHQUAKE ON THE MAGNETIC FIELD OF EARTH AND IONOSPHERE.

For the detection of the effect of Tashkent earthquake and its iterative impulses on the state of the magnetic field of earth and ionosphere, is produced the analysis of the geomagitno-ionospheric station of the institute of seismology the A.S. of the Uzb.SSR in the sett. of Yangibazar (about 30 km of epicenter).

With the direct survey of magnetograms, established/installed the absence of special phenomena in variations ir the magnetic field of earth from notation in Yangibazare during the basic earthquake and its iterative impulses. On differences in the hourly mean values of the components of the magnetic field strength of earth at the stations of Yangibazara and Alma Ata for the period from April through June 1966, are obtained the following results: the average differences in the horizontal component for night hours remain unchanged within limits n^1 gamma, which indicates the absence of the effect of Tashkent earthquake on the horizontal component of the magnetic field of earth.

Differences in the hourly mean values for night hours of vertical component give the absence of effect in limits $_n4$ gammas, which, taking into account the resolution of instruments, testifies to the absence of the effect of earthquake and on the vertical component of magretic field. This fact can be explained by a comparatively large distance from epicenter. Magretic observations in epicenter turned out to be nonproductive due to the powerful interferences, vazvannykh by the stray tram currents.

According to ionospheric observations is obtained somewhat a different picture. Are known at present the works on the effect of powerful earthquakes on the state of ionosphere. In the work of Deyvisa and Beykera (1965) as a result of the analysis of notation in Boulder (Colorado) the Doppler frequency shift of the echo from ionosphere signals to 4.5 and 1.0 MHz are reveal/detected per hour to and through half-hour after Alaska earthquake (0.3.35 world. vr. on 28 March 1964 near Ankoridzha) the special effects which were observed one additional time for four years during the high-altitude nuclear explosion above is. Johnston on 9 July 1962. The authors consider that the zamechenyy effect can be caused by the arrival of subsonic wave (period of approximately 30 s.) into the zone of polar ionosphere. On the direct measurements of acoustic waves from Alaska earthquake, it speaks in the note of Cock and Beykera.

In the work of Leonardo and Barnes (1965) are given the observational data of the critical frequencies of layer F_2 of the

icncsphere ct four ionosphere staticns: ccllege, Adak (Alaska), is fingered Al'tc (Califcrria) and Maui (Hawaiian islands).

Page 188. The authors ncte an increase in the critical frequency of layer F_2, which followed after earthquake. Furthermcre, are noted alsc the appearances of the unccmmon stratificatiens F_2.

In work Pay, it is assumed that the large lcng-period disturbance/perturbation cn the notaticns cf the Dcppler effect intc Bculder and cn the ionogrammakh cf aircraft scurding is a manifestation cf the long-period canalized akustiko-gravitaticnal waves, emitted into ionosphere near epicenter. It is assumed that at large distances from energy scurce lcng-pericd the component of fluctuaticns in essence is ccncentrated at heights cf approximately 100 km, i.e., in E-layer.

In the Scviet Union A. V. Tarantsov and Ya. G. Birfel'd they advance hypcthesis about the fact that the disturbance/perturbaticns cf polar ionosphere in esserce are determined by the powerful explcsicns, the earthquakes, by the vclcanic eruptions and cther energy sources, which are lccated at a distarce to 3000 km cf pclar circle and capable of emittirg vertical accustic vibrations. They prcpcse the fcllcwing diagram: earthquake is the long-wave akustiko-gravitational waves, which reach ionosphere, the excitation icncspheric by tsunami - the advance icncspheric by tsunami to polar latitudes (magnetic "sand-bars") - the razursheniye icnospheric by

tsunami and the formation/edication of ionospheric turbulences, detected by radars. A. V. Tarantsov and Ya. G. Eirfel'd they assert that in a number of cases catastrophical earthquakes precede the onsets of long-period oscillations of the earth's surface in the region of epicenter, which it is possible to note on the disturbance/perturbations of polar ionosphere or in the regions magretic anomalies.

We conducted materials research of the observations of ionosphere station in Yangibazare (aircraft sounding) for the period from April 1966 through March 1967. Special effects of the type of uncommon stratifications or abrupt changes the parameters of ionosphere (in particular layers F_1 and F_2) are not reveal/detected. For F-layer, is produced detailed calculation of the frequency deviations of the critical frequencies from median values for entire period - April 1966; March 1967 25-27 April 1966 noted an increase in the critical frequency of layer E on 0.12 MHz, which it is difficult to explain by the effect of solar activity. Analogous increases in the critical frequency were observed even for several "-scale-number iterative impulse, for example, on 24 May and on 29 June 1966 and on 24 March 1967. However, an increase in the critical frequency of layer E was observed not always, although sometimes the frequency rose in the absence of powerful jerk/impulses. Partially this can be explained by the effect of solar activity.

Thus, as a result of research on the material of ionospheric

observations is outlined certain dependence of an increase of the critical frequency of E-layer from the most powerful earthquakes; however, for the more urverennykh conclusions is necessary supplementary material.

FOREBUNNER OF TASHKENT EARTHQUAKE.

Research on the reasons for earthquakes by direct form is connected with the most important problem of the forecast/prediction of earthquakes.

Earthquakes are caused by the sharp shift displacement of rocks in the interiors of the earth's crust or in the deeper horizon/levels of earth, which, in turn, is caused by the maximally accumulated elastic strains which as the final result destroy solid medium.

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The failure of solid medium under conditions of high quasihydrostatic pressure does not occur unexpectedly. Absence, as a rule, the preliminary jerk/impulses before powerful earthquakes, and also the results of geodetic investigations in epicentral zones indicate the which precede discontinuity stages of the elastc-plastic deformation of rocks.

The deformation of the earth's crust in the focus range of

Tashkert earthquake have revealed we as a result of the analysis of the content of radon in termomineral'ncy water of Tashkent artesian basin (Ulomov, Mavashev, 1967, Ulomov, 1968). Termomineral'nye water will lie on depth 1300-2400 m in the water-bearing horizon/level of Senoman deposits. Water basin is supplied in essence because of atmospheric precipitation and surface water in the foothill parts of the Pritashkentskogo region, and also because of the migration of water of deep origin. The intensity of the admission of radiona or the change in the content in them of radon determine variations in the quantity of inert gas in termomineral'nom basin.

On the basis of the system of the tectonic disturbances in crystal basement, relative to the high temprautry of water (about 60°C), of weak radioactivity (less than 40 eman), it can be assumed that radonovye water are timed to the zones of tectonic fractures.

Radon - inert gas and its incidence/impingement into water it is caused by diffusion from the capillaries of rock/species, by emanation. As established/installed, the emanation is determined, in essence, by the structure of rock/species, by the presence in it of courses, on which the radon, which isolated from radium, falls into the environment. To the intense liberation of radon, obviously, contribute the failure of crystal lattices of minerals and development in the rock/species of the grid/network of "capillaries" (the possibility of the "capillary" chogasheriya of the chemical and gas composition of mineral waters repeatedly indicated V. I. Vernadskiy).

It is known that in some stages of geological development a change in the composition of mominеral'nykh water flow/lasts very slowly, and into the priody of intense geological processes, it can be very considerable. All this confirms the law governing the discovered by us phenomena.

For research on a change in the content of radon in termomineral'noy water of Tashkent basin during period, 1956-1967 sample/tests of water were undertaken (by colleagues of the scientific research institute of health resort science and physiotherapy im. N. A. Semashko) in the mouth of a deep blowhole, arrange/located ir immediate proximity (1-1.5 km) from the plenystoseystvoy range of Tashkert earthquake (Fig. 106).

Analyzing the obtained results and following the principles of the mechanics of the deformed media, we can with a sufficient degree of reliability and the account of actual conditions consider the deformation of certain volume of the rocks of hypocentral range as sequence of four stages (Fig. (106a):

I. The prolonged slowly growing elastc-plastic deformation, which is accompanied by the packing/seal of the large volume of rocks (coverage of pores, fine cracks, deformatior less solid, connection/inclusion etc.), in the extent/elongation of several summers, contributes to "squeezing" (but it is possible, and to the intensification of the dissolution of radon) from the rock/species

radcncscderzhashchey water.

II. Relatively rapid elastic deformaticn, which is alsc accompanied by decrease in the vclume cf rcck masses and by the disturbance cf crystal lattices of separate/individual minerals. In this stage in the extent/elcrgaticn of 3-4 mcnths alcng with "squeezing" the enrichment of water by radcn occurs. apparently, also cwing to the disturbances cf crystal lattices cf minerals and appearance cf new cracks in rock/species.

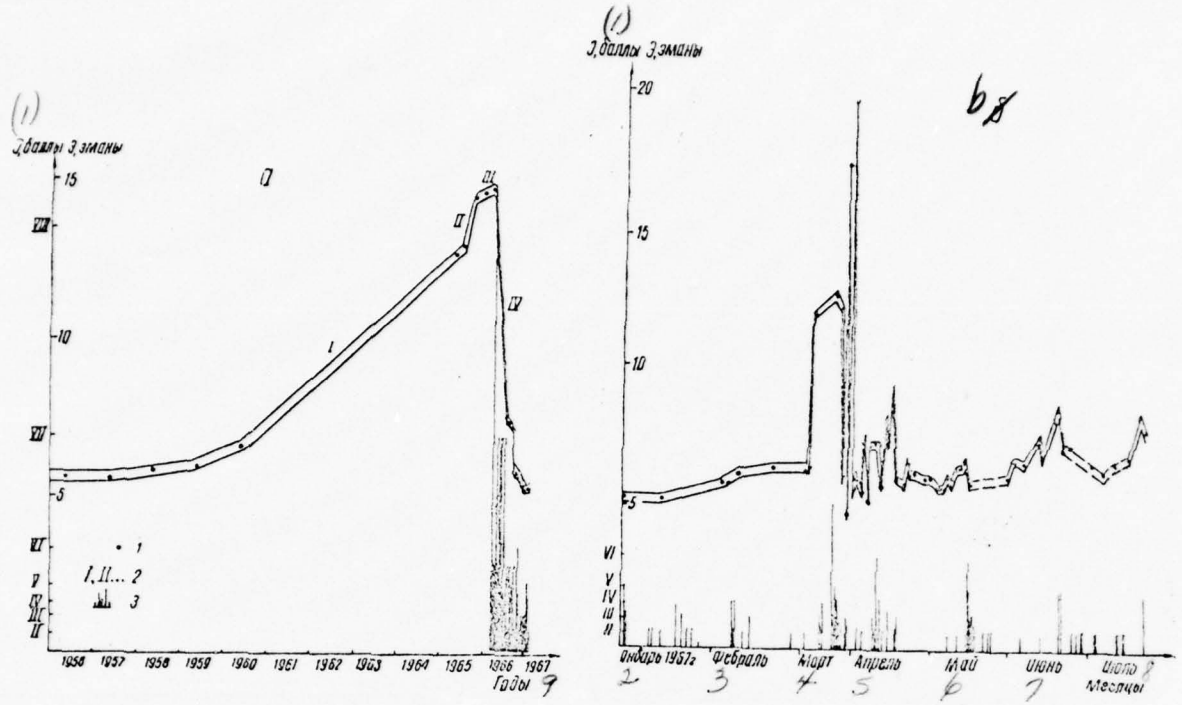

Fig. 106. Radon concentration in termomineral'noy water of Tashkent artesian basin from 1956 of 1967 (a) and from January through July 1967 (b) (width of the averaging strip corresponds to the value of the error of reading). 1 - data of the measurements of radon concentration; 2 - the stages of the deformation of rocks; 3 - Tashkent earthquake and its aftershocks.

Key: (1). , balls emans. (2). Yanvar'. (3). Fevral'. (4). March. (5). April. (6). May. (7). June. (8). July months. (9). Years.

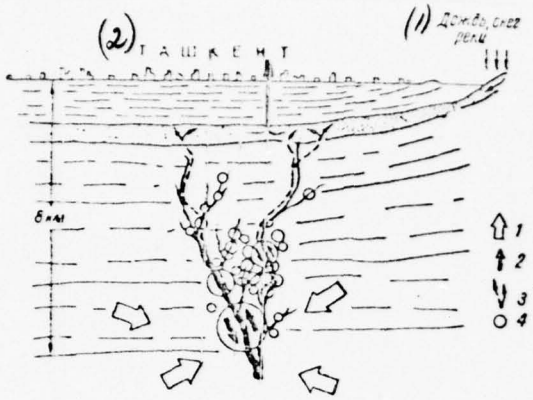

Fig. 107. Schematic cross section of focus range and the mecharism of the admission radonosoderzhashchikh water. 1 - the compressive elastic strains; 2 - the character of the premesheniya of rock/species as a result of discontinuity; 3 - the way of the admission "of that squeezed out" of the focus range of water into water-bearing basin; 4 - the giptsentry of the basic earthquake and its aftershocks.

Key: (1). Rain, snow of river. (2). Tashkent.

III. Plastic deformation virtually not being accompanied by a decrease in the volume of rock masses, stabilizes the admission of radon. This stage is completed by the sharp shift displacement of rock/species over the formed discontinuity - by earthquake.

IV. Elasto-plastic relaxation of the elastic strains, which arose as a result of the displacement of rock masses and deformation of the ambient focus range medium. This process is accompanied by the series of elasto-plastic fracture dislocations (iterative impulses) and is completed by the maximum release of the elastic strains in the range of origin/hearth. As a result gradually is restored the previous mode/conditions of the admission of deep water and, consequently, also radon (Fig. 107).

The obtained by us curve of the content of radon is analogous in configuration to the curve/graphs of the deformations of the surface of the Earth, obtained by geodetic methods ir are epicentral the zones of powerful earthquakes (Meshcheryakov, 1968). In view of the absence of the frequent measurements of radon concentration during the first three months after the main earthquake it is possible to judge only on the whole a decrease in its value in the period of powerful iterative impulses and to approximately evaluate the fluctuations of gas component.

However, as a result of organization toward the end 1966 more frequent measurements it was possible to establish that shortly before powerful iterative impulses (9-11 energy classes) in a number of cases

also was observed a noticeable increase in radon concentration in termomineral'nay water (see Fig. 106b). So, on night from 14 on 15 March 1967 content of radon sharply increased from 6 to 12 eman, were held at this level within a week, and on 24 March in Tashkent it occurred "-scale-number earthquake (K = 11). Radon concentration began to sharply vary in the range from 4 to 20 eman, approaching a datum level. Similar picture was observed during weaker jerk/impulses.

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It is possible that in the case of iterative impulses the mechanism of the admission of radon several different.

Thus, direct by the forerunner of the possible disturbance of the completeness of rocks can serve the initiated after rapid growth stabilization, and possibly, and a decrease in radon concentration in termomineral'nay water of deep origin.

ATTEMPT AT FORECASTING THE TORQUE/MOMENT OF THE EMERGENCE OF THE ITERATIVE IMPULSES OF TASHKENT EARTHQUAKE ACCORDING TO OBSERVATIONS OF A VARIATION IN THE RADON.

In this work are given the results of the issledovaniy of the radonovogo mode/conditions of termomineral'nykh water for forecasting the earthquakes, which initiated from May 1967. By laboratory of the

gidrogeokhimii of the institute of seismology the A.S. of the Uzb.SSR. Assumption about the possibility of this forecasting is expressed by V. I. Ulomov and B. Z. Mavshev (1967) on the basis of data on the measurement of radon concentration in underground water, obtained in NII [NNN - Scientific Research Institute] physictherapy and health resort science im. N. A. Semashko.

Observations were carried out on blowhole 4, arrange/located in immediate proximity of the pleystoseystovoy range of Tashkent earthquake and on a series of the blowholes of termomineral'nykh water of Tashkent region.

Blowhole 4 is drilled to depth 2000 m in the center section of the Tashkent artesian basin. The determination of radon concentration in water was realized by well-known procedure (grams, etc., 1957): radon by means of bubbling is translate/transferred from the sample/test of water into the ionization chamber where its content is measured on the electrometer of SG-1M.

As a result of measurements conducted and data on seysmoaktivnosti during the indicated period (Fig. 108) established/installed that the cycles by the increased seismic to aktivnoti coincide with the intense fluctuations of radon concentrations in termomineral'noy water.

The releasing energy during the indicated earthquakes is

approximately proportional the area of a curved increase in the content of radon, bounded below by the minimum values to the beginning of increase and after a decrease in the concentration.

The minimum of radon concentration after decrease is usually higher than the minimum prior to the beginning of the increase: the intensity of jerk/impulses also is approximately proportional to the amplitude of a curved increase in the content of radon and, apparently, depends on the character of change in maximum (plateau) curve, that precedes jerk/impulse.

With shch-scale-number jerk/impulses the time from the torque/moment of the maximum value of radon concentration to the torque/moment of earthquake is 20-26 hours, while with repeated shch-ballynyx jerk/impulses, immediately the following after each other 40-50 ~~shach~~ h. The character of a change of radon concentration in the period of seismic activity in the majority of cases is expressed by the following regularity: increase - decrease - increase - jerk/impulse - increase.

However, in the nakotorykh cases jerk/impulses occur already on the first decrease. It is obvious that to nadezhnot' the plotting of curves of the content of radon depends on frequency and accuracy of the conducted analyses.

For the determination of statistical communication/connection between the content of radon in water and the intensity of the

expected jerk/impulse according to observed data, is produced mathematical development of the method of correlation analysis. As the initial data are taken the nearest maximum values of the content of radon, which preceded jerk/impulses, and the intensity of aftershocks (Vorobyev, Zakirov, 1968).

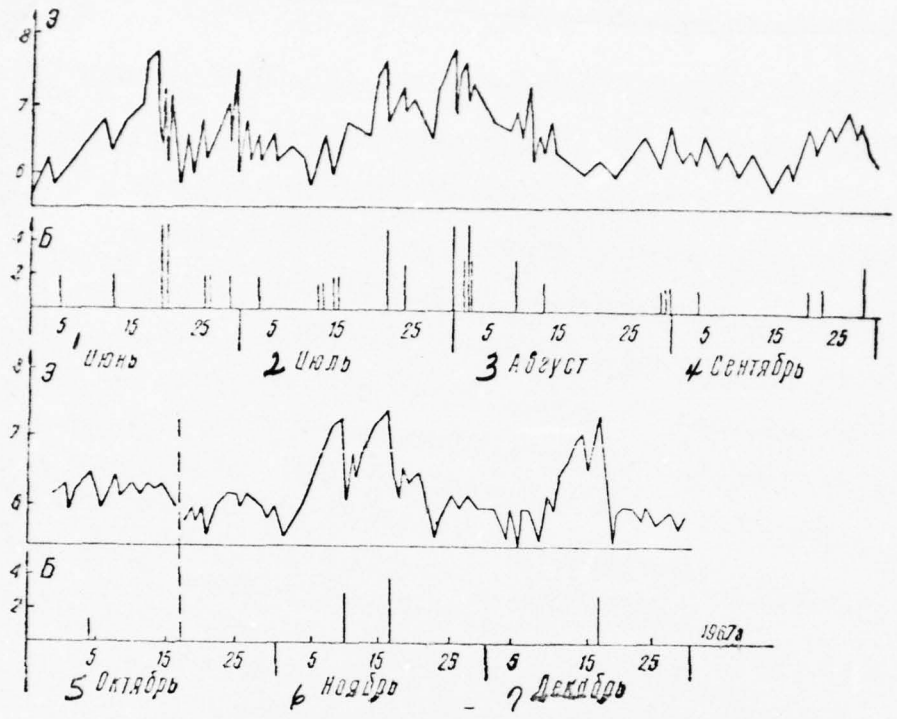

Fig. 108. Change in the content of radon in termomineral'ncy water of Tashkent artesian basin (on SKV [СКВ. - blast hole] 4) and the intensity of iterative impulses (E - the content of radon in termomineral'ncy water in emans; B is force of iterative impulse in balls).

Key: (1). June. (2). July. (3). August. (4). September. (5). October. (6). November. (7). December.

The calculation of empirichesoy dependence y_x on x is made by well-knowwn diagram (lengths. 1958) (Table 19), where are given quantities of jerk/impulses (x) at the different values of the content of radon in water (y).

On the curve/graph of empirical regression line (Fig. 109) it is evident that the character of communication/connection between (y) and (x) rectilinear, i.e., can be described by the equation of form $\bar{y}x = ax + B$. The coefficient of the equation of regression (a, b) is calculated with the aid of the least squares:

$$a = 0{,}4;$$
$$b = 5{,}81$$

the equation of the regression:

$$y = 0{,}4\,x + 5{,}81.$$

the correlation coefficient between these values is calculated according to the formula:

$$r = a\frac{\sigma_x}{\sigma_y} = 0{,}84,$$

where σ_x, σ_y is the root-mean-square deviation x and y.

$$\sigma_x = h_x \sqrt{\frac{\sum m_x x'^2}{\sum m_x} - \left(\frac{\sum m_x x'}{\sum m_x}\right)^2};$$
$$\sigma_y = h_y \sqrt{\frac{\sum m_y \cdot y'^2}{\sum m_y} - \left(\frac{\sum m_y y'}{\sum m_y}\right)^2}.$$

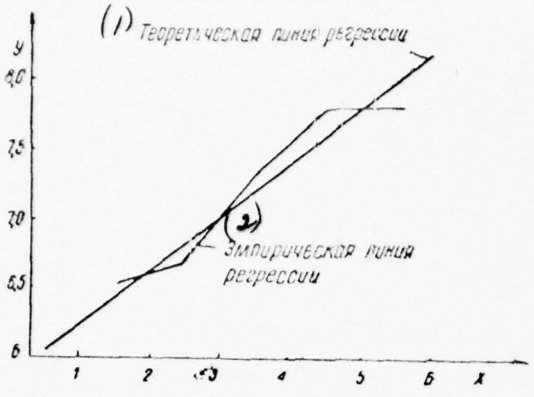

Fig. 109. Curve/graphs of regression.

Key: (1). Theoretical regression line. (2). Empriicheskaya pine of regression.

Table 19. Quantity of jerk/impulses (x) at the different values of the content of radon in water (y).

	x'		−2	−1	0	1	2	
y'	y \ x		(1) баллы					m_y
			1–2	2–3	3–4 $x_0=3,5$	4–5	5–6	
−2	(2) значны	6,2 –6,56*	5	3				8
−1		6,56–6,92	3	5				8
0		6,92–7,28 $y_0=7,1$		1	1			2
1		7,28–7,64			1			1
2		7,64–8,0				3	1	4
	m_x		8	9	2	3	1	23
	$\Sigma m_{xy} y'$		−13	−11	1	6	2	
	$\bar{y}'_x = \frac{\Sigma m_{xy} y'}{m_x}$		− 1,63	− 1,22	0,5	2	2	
	$\bar{y}_x = y_0 + \frac{\Sigma m_{xy} y'}{m_x} \cdot h_y$		6,51	6,66	7,28	7,82	7,82	

* Intervals $h_y = 0{,}36$ eman; $h_x = 1$ tc ball.

Key: (1). balls. (2). emans.

Average kvadraditnaya error cf the koefftsiyenta cf correlatien $\sigma r = 0{,}061$. Its value lie/rests at repartitien/cenversiens $r \pm 3\delta r = 0{,}84 \pm 0{,}18$; consequently, the correlation coefficient reliable.

The calculated dependence of the cortent cf radon in water on the intensity of the expected earthquake is used, apparently, only tc Tashkent epicenter, but fcr cther regicns this tc zavisimot' can have arcther character.

The main disadvantage in the described methcd of the determination cf radon ir water is the labcr expense and the duration cf analysis, than and is limited the frequency cf sampling. The curve/graph, constructed acccrding to the reaul'tatam of testing, gives crly the qualitative concept atcut the character of a change in the content of radon in water.

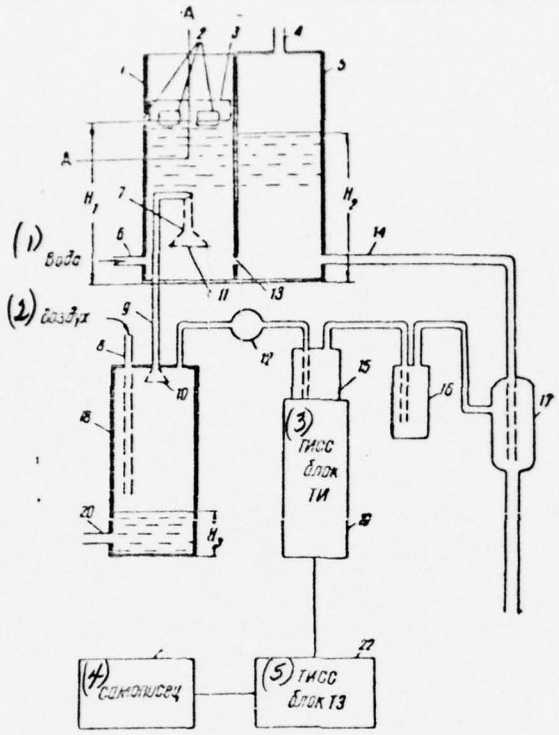

Fig. 110. Installation diagram of the continucus measurement of the ccntent of radon in water.

Key: (1). Water. (2). Air. (3). Yew is blcck/module/unit . (4). recorders.

During October 1967 in the laboratory of gidrogeokhimii, are initiated the production tests of the first experimental installation of the continuous automatic method of measurement of the concentration of the radon in water, developed with the colleagues of the indicated laboratory. The action of installation entails that that the radon, which separates in aeratsionnom container (18) (Fig. 110), from water taking place is pumped through by water-jet pump (17) through scintillation chamber (15), where its content continuously is measured and is recorded by recorders. The content of radon in aeratsionnom container and the scintillation chamber equally depends on an output of water, concentration of radon in it and a quantity of pumped through air.

Constant flow rate/consumption of the water through aeratsionnyy container automatically is supported by float chamber (1) and does not depend on the pressure of water in blowhole. The productivity of water-jet pump, and consequently, a quantity of pumped through air also remains constant, i.e., water level in container does not change.

The consumption of water from blowhole for providing a normal operation of ustaovki is 1.8-2.0 l/min.

Electrics of the installation is made on the basis of universal radiometer yew. The principle of the measurement of radon concentration is based on the known phenomenon of the phosphorescent glow (ZnS) of the scintillation chamber under the effect of the α-particles, which are formed as a result of radioactive decay of

radcn.

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Light momentum/impulse/pulses are ccnverted by electronic phctcamplifier (photomultipliers) intc the electric pulses which enter the amplifier-measuring blcck/mcdule/unit (TZ [- Technical Task]) cf radicmeter. The first cascade/stage cf block/module/unit is assembled by the diagram cf mcnostable multivibratcr and is intended fcr a rcrmalizer momentum/impulse/pulses they apprcach integrating chain/network $(C_n R_n)$. In the diagcnal cf the recorder, collected by bridge circuit, is included the recording milliampere.

The position of the indicated arrow/pcinter of peropistsa is prcportional to voltage cn the integrating cutlire, i.e., tc an average quartity of momentum/impulse/pulses, which enter frcm photomultiplier per unit time.

Fcr the systematic functicnal check cf entire circuit to phctoelectric cathode photomultipliers instead cf the scintillation chamber, is establish/installed the ccntrcl preparation, a quantity cf alpha-decays cf which is strictly calibrated. Its readings are fixed sacpistsem and during prccessing diagram tapes are considered in the fcrm of corrections.

Error in the determination of the medium frequency of input

pulses is store/added up by the couning rate meter of statistical error and error in the measuring device (needle indicator). Due to the statistical character of radioactive decay for each sufficiently podolzhitel'nyy time interval (1-2 min.) the number of recorded particles N can differ, according to the probability theory, by the value of standard deviation (fluctuation);

$$D = \pm \sqrt{N}.$$

Root-mean-square to pogreshnot' the measurement of counting rate it is determined by the formula:

$$\sigma = \frac{1}{\sqrt{2N\tau}},$$

where τ it is determined the time constant of the integrating cutline. Substituting in formula (1) the number of momentum/impulse/pulses, recorded with blowhole 4 - $N \approx 15$ imp./s and the time constant of the integrating circuit - τ = 100 s., we obtain root-mean-square error with probability P = 0.682 (normal law of distribution), equal to $\sigma = \pm 1.8\%$, and with probability P = 0.95 - $\sigma = \pm 3.6\%$. in installation are utilized the recorders, which have class of accuracy 1.5-2, i.e., an error in them with probability P = 0.95 is equal to $\sigma = \pm 1.5\text{-}2\%$.

A general error of measurement by continuous method with probability in P = 0.95 with the content of radon in steady state 6 eman composes $\sigma = \pm 5.6\text{-}5.1\%$, with 0.34-0.31 emans.

From correlation table (Table 19) it is evident that the increase of the content of radon in water in 8 cases to 0.36 and in 8 cases to 0.72 emans precedes earthquakes by force to three balls. Among the fact, the confident fixing of increase with probability P = 0.99 can be during a change in the content of radon in water the greater doubled rms error, determined with probability P = 0.95, i.e., 0.68-0.62 emans. Therefore the probability of forecasting the jerk/impulses by force is below 4 balls less than 0.5. This conclusion is confirmed by curve/graph (Fig. 111) whose analysis shows that of 7 cases of an increase in the content of radon in water by 0.5-0.7 emans only into 3 cases occur the earthquakes by force to 4 balls.

Earthquakes above 4 balls precedes an increase in the content of radon in water to 8 eman, i.e., by 8 emar higher than stationary content. Hence the probability of forecasting earthquakes from 4 to 5 balls significantly higher is equal to 0.8-0.9.

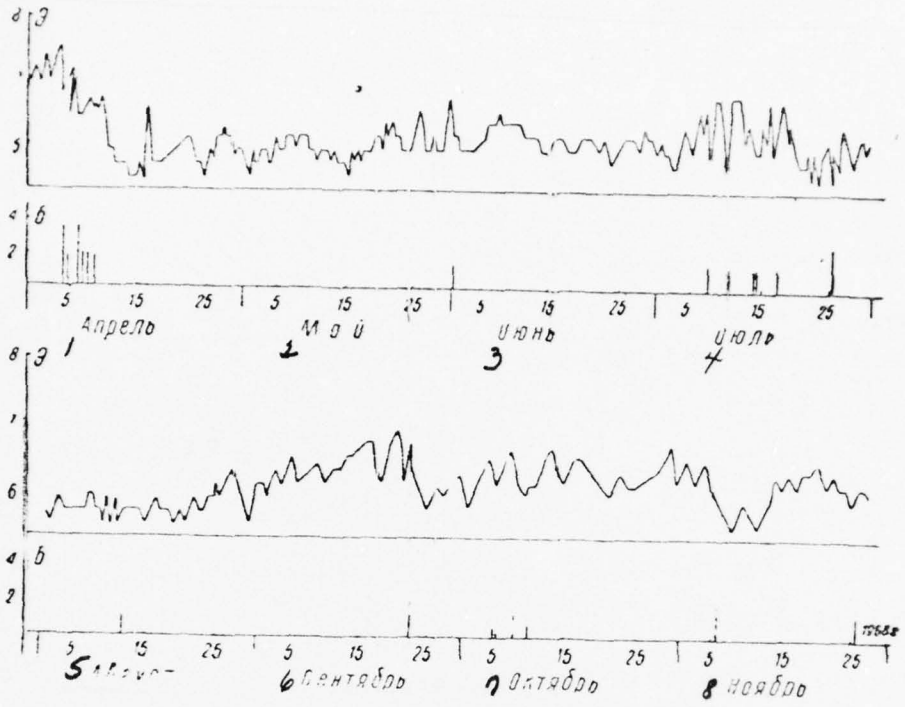

Fig. 111. Change in the content of radon in termomineral'ncy water of Tashkent artesian basin (on SKV 4; the measurement produced continuous method).

Key: (1). April. (2). May. (3). June. (4). July. (5). August. (6). September. (7). October. (8). November.

For the calibration of the scale of notation in emans, are simultaneously produced the measurements by two methods - continuous and diskretrymPo to the results of these measurements it is constructed the calibration curve/graph of the translation/conversion of the scale divisions of notations into emars. In accordance with calibration curve/graphs and the notations of readings from control preparation, is produced processing diagram tapes.

By the major advantage of the proposed method is its simplicity and the reliability, the main disadvantage, i.e., low sensitivity.

CONCLUSIONS.

As show the results of investigation, before the aftershocks of Tashkent earthquake, occurs a regular change in the content of radon in Tashkent termomineral'noy water in the diagram: increase - decrease - increase - jerk/impulse is ar increase, or increase - decrease - jerk/impulse - increase.

This regularity can be explained by the following considerations. Tashkent termomineral'naya water is timed to the Senoman deposits whose depth in the investigated blowholes reaches to 2000 m. The supply of power of Tashkent artesian basin is in essence the atmospheric precipitation of foothill regions. and, possibly, water of the deeper origin, because of migration of which they are enriched the salt and gas composition of the first. Together with deep water also occurs the migration of gases, which is the radon.

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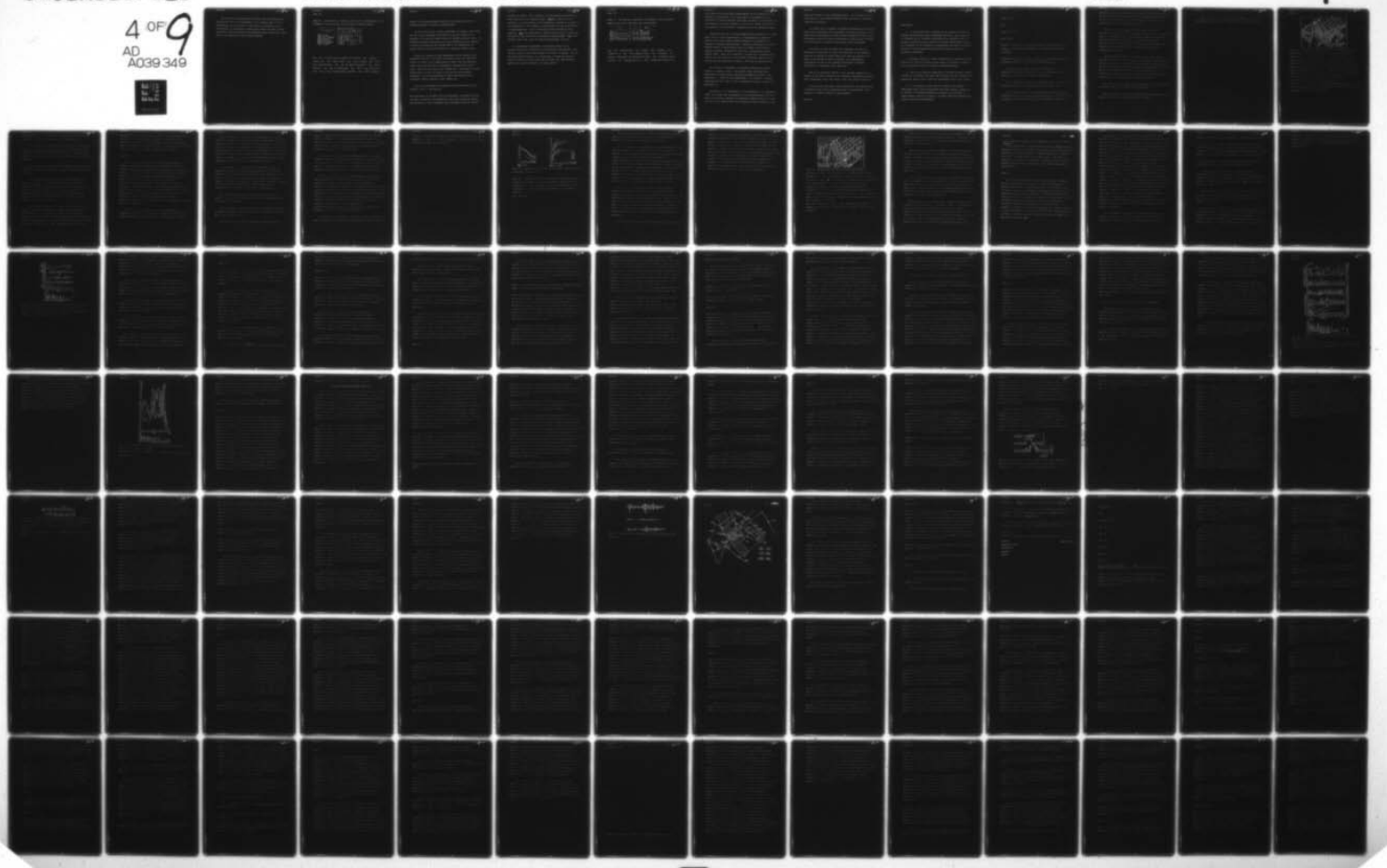

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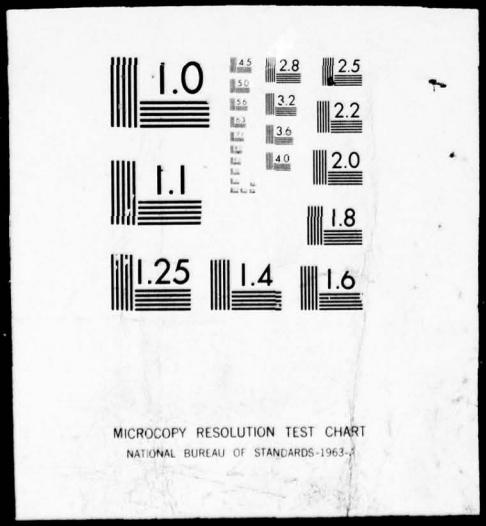

"botany" in the territory of the imperial of

The results of investigations show that with shch-scale-number jerk/impulses from the torque/moment of the maximum value of radon concentration (i.e. from time of the onset of plasticity) to the torque/moment of earthquake it passes 20-26 hours, and with repeated "dupletnykh "shch-scale-number jerk/impulses passes 40-50 hour. These data are preliminary and need careful checking.

Table 20. Concentration of helium, radon and the relationship of the isotopes of uranium in the mineral waters of Tashkent basin.

1 Местоположение и номер скважины	2 Гелий, объем. %		3 Радон, эманы	$\frac{U^{234}}{U^{238}}$
	1963–1965	1966–1967	1963–1965	
4 Скв. 8, Кибрай	0,025	0,276	6,5–7,0	6,2
5 Скв. 3, пос. Луначарского	0,014	0,174	5,2	7,0
6 Скв. 7б, парк «Победа»	0,034	0,127	—	—
7 Скв. 7, Чинабад	0,028	0,044	4,0	3,4
8 Скв. 5, Ташминводы	0,038	0,024	3,5–5,0	4,2
9 Скв. 9, д. о. «Ботаник»	0,142	—	—	3,0
10 Скв. 2, ст. «Пищевик»	0,041	—	4,0	—
11 Скв. 1, ТашМИ	0,154	—	3,3–5,0	

Key: (1). Location and the number of borehole. (2). Helium, volume, c/c. (3). Radon, eman. (4). SKV 8, Kibray. (5). SKV 3 sett. Lunacharskogo. (6). SKV 7b, parak "conquest". (7). SKV 7, Chinabad. (8). SKV 5, Tashminvody. (9). SKV 9, d.o. "botanist". (10). SKV 2, stage "food-industry worker". (11). SKV 1, TashMI.

EFFECT OF GEOLOGICAL-TECTONIC FACTORS ON THE CONTENT OF GASES IN UNDERGROUND WATER OF TASHKENT ARTESIAN BASIN.

In the period, which precedes earthquake in Tashkent (1963-1967), and also during earthquake (1966-1967) by us were conducted the analyses of the thermal mineral waters of Tashkent artesian basin. In 1966-1967 produced determination of the relationship of the isotopes of uranium (uranium-234 and uranium-238) in the sample/tests of mineral waters from several blowholes of Tashkent artesian basin.

During the analysis of the sample/tests of the dissolved gas, selected in period of 1963-1967, ustanovleno, which into 1966-1967 content of helium in the sample/tests of water from the blowholes, located near the epicenter of earthquake, increased more than 10 times. There are also data on an increase two - five times of radon concentration in water of basin in the periods, which precede earthquake, and the stabilization of radon concentration after earthquake (Ulomov, Mavashev, 1967) (Table 20).

three first blowholes are arranged near fold-disruptive zone, blowhole 4 and 5 - far from it.

TAB apparently, an increase in the concentration of helium and radon in water is caused by the existence of the close connection between the processes of their liberation from rock/species and the tectonic

activity of region. This increase it is not possible to explain by a usual increase in the emanating power ($K_{эм}$) in radon and in the analogous to it coefficient of the liberation of helium as a result of the disturbance of the entirety of rock/species (in the origin/hearth of zemlegryaseniya). Such a conclusion confirm laboratory works regarding $K_{эм}$ the sample/tests, selected from the core of blowholes, and also the fact that during pulverizing specimen/sample $K_{эм}$ only somewhat higher than $K_{эм}$ the same specimen/sample in piece.

In contemporary understanding the seismic center is the discontinuity of the continuity of rock/species, which appears, when tectonic stresses exceed the ultimate of strength of medium. Besides the basic discontinuities, in rock/species is formed the enormous number of large and small cracks each of which with vozbuzhdenii excites the elastic vibrations of higher shastot.

Table 21. The isotopic composition of uranium in the underground water, timed and to different type rock/species.

1 Порода	$\frac{U^{234}}{U^{238}}$	2 Автор
3 Граниты	2,0 —5,0	4 Исабаев Е. А.
5 Другие изверженные породы	2,5 —4,0	Исабаев Е. А.
6 Известняки	1,03—1,05	Исабаев Е. А.
7 Другие осадочные и метаморфические породы	1,5 —2,5	Исабаев Е. А.
8 Палеозойские глины, сланцы	1,20—1,36	Чердынцев В. В. 9
10 Песчано-глинистые породы	1,12—1,60	Чердынцев В. В.

Key: (1). Rock/species. (2). Author. (3). Granites. (4). Isabaev e. A. (5). Other igneous rocks. (6). Limestone. (7). Drutiye sedimentary and metamorfrye rocks. (8). Paleozoic clays, schists. (9). Cherdyntsev V. V. (10). Sardy-clay rock/species.

As a result of the laboratory investigations of the processes of the failure of rock/species, it is noted that the disturbance of the continuity of specimen/samples with their elongation is accompanied by the emergence of elastic impulses in the form of damped sinusoid with the maximum of the spectrum at frequencies 10-80 kHz (Shamina, 1956).

During the failure of specimen/samples under pressure, it is also noted that the final fragmentation of specimen/sample precede the numerous fine cracks whose formation/education is accompanied by ultrasonic momentum/impulse/pulses. Analogous phenomena occur before mountain shocks in shaft/mines, rises the number of the acoustic impulses (acoustic noisiness) of coal beds (Constantinov, Mysina, Ivanov, 1965). Thus, it is possible to assume that in seismic center appears the wide spectrum of the elastic vibrations, which stretch from the portion/fractions of hertz to 10-80 kHz and possibly more.

As a result of earthquake, is separate/liberated an enormous quantity of elastic energy. For example during earthquake with magnitudoy 4 seismic energy comprises approximately $1.6 \cdot 10^{11}$, with magnitudoy 6 - $3.0 \cdot 10^{14}$, with magnitudoy 7 - to $1.5 \cdot 10^{16}$. Tashkent earthquake was the series of the jerk/impulses majority of which had magnitudu 5.3.

In work of V. G. Gratsinskiy, I. V. Gorbushincy, V. G. Tyminskogo (1967) it is shown that propagation in the specimen/samples of solid rocks of the elastic impulses of ultrasonic frequency band (to 30 kHz) it leads to the liberation of the containing in them radioactive gases

(radcn and thcron) tc the surrounding space. It is cbvious, not in less measure it is separate/liberated urder the action of ultrasonic vibraticns and helium.

The reascn for an increase in helium ccrcentration (and radcn) in water after earthquake, are, apparently, nct crly an increase in the emaratien of rock/species in radon and the liberation of helium frcm the weakened zones, but alsc the extractien cf gases under the action cf the ultrascnic vibrations, which appear during earthquake.

The source of gases in water are, clvicusly, not only the Cretaceous rock/species, but alsc the granitcids of the paleozoic basement cf Tashkent artesian basin, with which are connected the water in the process of their fcrmatien. The supplementary ccnfirmation of this is the isotopic ctncshsniye of uranium (U^{234}/U^{238}) in Cretaceous water (Table 20).

Data of the different authcrs cn the isctcpic ccmposition cf uranium in the water, connected with different rcck/species (Isabaev, 1961; Cherdyntsev, 1961; the tawers, 1961), are given in Table 21.

As can be seen from table, ratio U^{234}/U^{238} in the mineral waters cf Tashkent basin high and analogous with the relationship cf the isctopes of uranium in water cf granite masses.

CONCLUSIONS.

1. Is reveal/detected an increase in the content of helium in Tashkent mineral waters after earthquake 1966-1967. This phenomenon is explained by the increased tektonichescy and connected with it acoustic activity of region during this pericd, which leads not only to an increase in the emanation of rock/species (on radon and helium), but also to their supplementary extraction under the action of ultrasonic vibrations.

2. Combined analysis of radium distribution in rock/species and water and of radon and helium in water makes it possible to explain the most probable sources of helium in underground water.

3. Data on the isotopic composition of uranium in mineral waters confirm the conclusion that water are connected with the intrusions of granitoids, whence enters water the considerable part of the helium.

4. On an increase in the content of gases in the mineral underground water, which escape/ensue from large depths, probably, it is possible to establish/install the beginning of the period of taktonicheskoy activity in region. The giver data and considerations require further podtverzhdeniyey.

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Results of research on the mode/conditions of thermal water in a region g. of Tashkent in communication/connection with Tashkent earthquake.

Pritashkentskiy artesian basin occupies the northeastern part of the analogous/similar foothill tectonic basin/depression.

In northeast and south, the basin is limited by Chatkalo-Kuraminskimi mountains, on west and northwest has free outcrop to the side of sand plain the kizil-kums.

In the geological structure of basin/depression, takes part of the rock/species of paleozoic, Mesozoic and cainozoic ages.

The tectonic situation of Pritashkentskogo artesian basin was predetermined by the processes, poiskhodyashchimi in the earth's crust generally and in paleozoic deposits, in particular. Judging by

magnitorazvedochnym, gravitation prospecting and seismic survey data, the rock/species of Paleozoic period are strongly dislocated, broken by the series glubinnykh and regional fractures, which were being repeatedly renewed in mezokaynozoyskoye time.

There are several diagrams of the tectonic structure of Pritashkentskogo region. In one of them, comprised as N. B. Vol'fson and A. G. Khvalovskiy along the last/latter results of geophysical investigations, the most ancient system of the fractures of northwestern strike/course (Almalykskaya) passes near Tashkent and intersects by the revived regional fractures of northeastern strike/course (Fig. 112).

Hydrogeological conditions of region. On the basis of the alternation of the layers of different permeability in Pritashkentskom artesian basin, it is separate/liberated five water-bearing complexes (in quaternary, neogene, Paleogene, Cretaceous and Jurassic deposits), which possess different pressure heads, mineralization and productivity. Furthermore, water-bearing can be paleozoic deposits, especially on the fractures, secant paleozoic basement.

Most vodoobil'ny are chetvirtichnye deposits. Their water widely are utilized for a water supply and an irrigation.

Among the water, timed to dochetvertichnym to rock/species, the greatest value they have thermal water of senomana.

They are revealed for the first time in 1948 on the area of Ishankurganskoy structure in the process of search boring to oil.

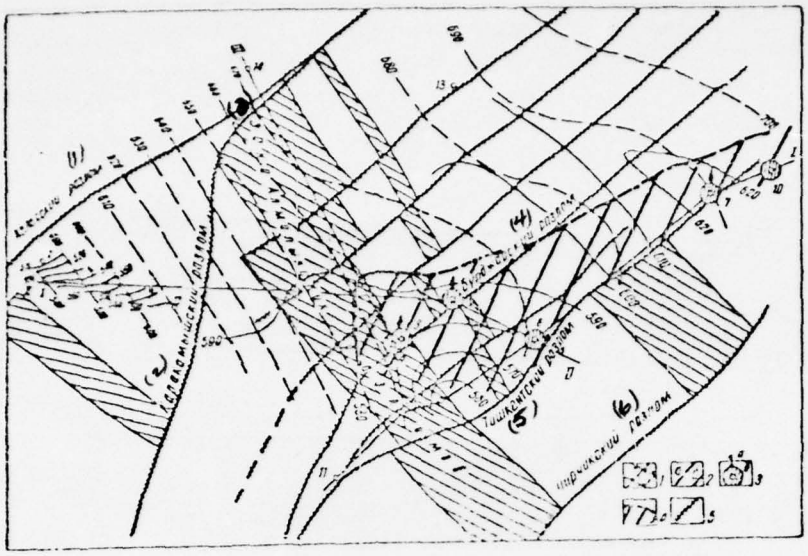

Fig. 112. Diagram of the gidroizop'yez of sekcmanskogo water-bearing horizon/level with reading the zone of changes in the physical parameters. 1 - fractures (according to n. b to Vol'fsonu and A. G. Khvalovskiy); 2 - gidroizop'yezy (a - prior to the operation of water-bearing horizon/level, restoration/reduction on calculation, b - for second half-year 1966); 3 - the zone of noticeable changes in the physical parameters (t°, P); 4 - the blowholes in which are noted changes in the physical parameters (a - an increase in pressure heads, b - an increase in the temperature); 5 - the fracture, established/installed from hydrogeological data.

Key: (1). Kelesskii fracture. (2). Karakamyshskiy fracture. (3). Zone Almalykskikh fracture. (4) Burdzharskiy fracture. (5) Tashkent fracture. (6) Chirchikskiy fracture.

Subsequently these water, possessing therapeutic properties, began widely to be utilized for balneological target/purposes.

Senoman water weakly mineralized, with plotym residue/remainder 0.5-1 g/l, are thinner - more than 1 g/l, gidrokarbonatno-sulfate-soda, gidrokarbonatno-xloridno-soda composition. Sometimes they xloridno-gidrokarbonatno-soda with pHs = 6.8-8.2 m, but, in essence alkaline.

Among the most widespread components (HCO_3, SO_4, Cl, Na, Mg, CA) is noted the increased soderzhniye of silicon (SiO_2), which composes 20-40 mg/l.

The power supply of the water-bearing horizon/level of the deposits of senomana is realized by means of the overflow of interstitial water of paleozoic rock/species in the places of the transgressive leaning on them of the deposits of chalk. It is possible that as the supplementary factor of the power supply of Senoman water-bearing gorizota can serve the fractures, secant paleozoic and Mesozoic deposits.

At the present time within the limits of the Uzbek part of the basin, is drilled 14 blowholes to thermal water the senomana: in Tashminvodakh, in the institute of health resort science and physiotherapy im. Semashko - on two blowholes, in the territory of the palace of water sport, in sott. Lunacharskom, TashMI, in the institute of nuclear physics, into the Sun. "Chirabadskiy", into the Sun.

"botany", in the territory of the hospital of Tekstil'kombinata, in the institute of vegetable-melon cultures and potatoes, in the institute of shredder and g. to Yangiyule - on one. All blowholes work in fontannom mode/conditions, having a overpressure on mouth from 9 to 16 atm. and a temperature of water from 48 to 70°C.

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For research on a change in the expenditure/consumption, pressure, in the chemical composition and temperature of water of Sernman water-bearing horizon/level in the process of the operation of blowholes from 1960. By uzbek hydrogeological trust are initiated routine (1-2 times per annum) gidrorezhimnye observations with the method of single fixing on the mouth of the blowhole of expenditure/consumption, pressure and temperature. By these observations established/installed that the chemical composition of water during the period of the operation of blowholes did not change and was found to 26 Apr. 1966 in stable state. Because of the srabotki of elastic supplies, gradually fell the pressure. Respectively decreased the consumption and the temperature of water on the mouth of blowholes.

Observations of gas composition and the concentration of microcomponent in water they conducted sporadically, but according to separate/individual blowholes they were not carried out generally.

From May 1966 on ten blowholes (in Tashminvodakh - No 1, the institute im. Semashko is No 4, the palace of water sport - No 5, pos Lunacharskom - No 6, the institute of nuclear physics - No 7, TashMI are No 8, the Sun. "Chinabadskiy" - No 9, "botanist's Sun. " - No 10, Tekstil'kombinate is No 11 and the sett. of Saryagach - No 14) by the uzbek hydrogeological trust of organizcany the quickened (2-5 times in month) observations of changes in the consumption of pressure heads, temperature, the chemical and gas composition of water.

The selection of gas sample/test was conducted by means of Savchenko's bottle by the capacitance/capacity 11 l and the pump Kamovskogo. The used method is incomplete. With evacuation from the bottle of air it is not always possible to achieve the determined vacuum, in consequence of which are possible the high values of oxygen and nitrogen in the volume of the selected sample/test, and consequently the percentage of other gases is understated.

The sample/tests of water and gas were directed to for an analysis for the central khimlaboratoriyu of the Ministry/department of geology of the Uzb.SSR.

The temperature of water was measured on the mouth of blowholes by mercury thermometers, and pressure heads - by specimen manometers with scale value 0.083 atm.

Most precise danye about the temperature of water, pressure

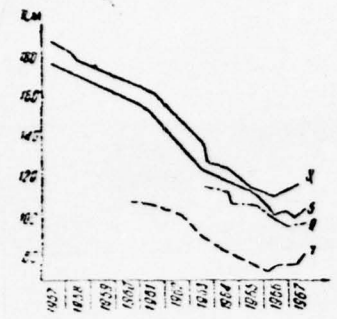
heads, consumption and the coefficients of fl'tratsii are obtained with the production of the gidrorezhimnykh tests by means of test water discharges in three odnosutochnykh operating modes of blowhole. The Tempratura of water and consumption in each operating mode of blowhole were fixed after one day of issue.

As a result of the analysis of gidrorezhimnykh test results, established/installed that the specific outputs, and consequently also the coefficients of fil'tratsi in extent/elongation 1966 remained the same as to earthquake. This makes it possible to assert that the kollektorskiye svoytva of layer are not disrupted push earthquake.

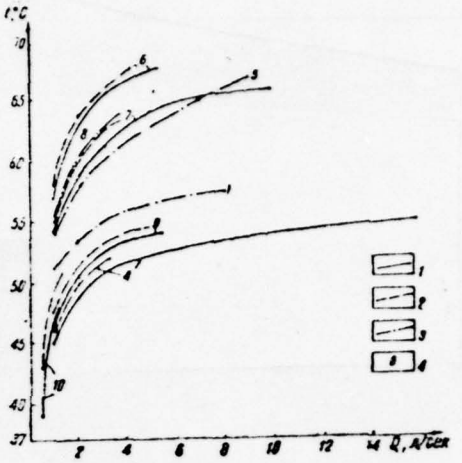
From the torque/moment of the input/introduction of blowholes into operation, was observed the intense srabotka of the levels, especially in Tashkent, where placed greatest klichestvo of water-intake soruzheniy. A decrease in the level in the center of the formed district funnel of depression reached 100 m (Fig. 112). If we prosmatrivat' the curve/graphs of the srabotki of levels in time (Fig. 113), then it is possible to note that the decrease in the majority of blowholes regularly continued up to earthquake. The field of earthquake in blowholes 4, 6, 8, 10 occurred the retarding/deceleration/delay of the srabotki of the levels, and in blowholes 3, 5, 7, 9 they even they increased.

The greatest lift of level by earthquake is noted in blowhole 7, where beginning from July 1966 piezometric level to middle 1967 vyros

cn 9.5 m. In blowhole 3 during this same period, it rose on 5.5 m, in blowhole 5, it rose to 3 m and in blowhole 9 - or 1.5 m for the period from December 1966 through May 1967.



Dig. 113.



Dig. 114

Fig. 113. Curve/graphs of a change in the static piezometric levels in blowholes 3, 5, 7, 9.

Fig. 114. Graph/diagrams of the dependence of temperature from the consumption of water on the mouth of blowholes before and after earthquake. 1 - the temperature of water to earthquake; 2- after earthquake; 3 - before and after earthquake; 4 - the number of blowhole.

Key: (1) l/s.

An increase in the levels, as a rule, is observed in blowholes, which are directly located in the zone of the strike/course of Tashkert and Burdzharskoge fractures, or near them.

In the majority of the blowholes where increased pressure heads, rose temperature. It is possible that the zones of these two fractures after earthquake were active wires of deep water to surface. A change of these parameters noted and in blowhole 11 (Tekstil'kombinat), but unlike other blowholes here (during operating cycle of its from April through October 1966) was observed a reduction in the pressure head, consumption and tempratury. If during April pressure head on the mouth of blowhole was 150 m, then in the beginning of October it was lowered to 32 m. With a decrease in the level, the water respectively were lowered consumption (with 8.37 l/s to 2.42 l/s) and the temperature of water (from 73 to 60°C).

The rate of the snatki of pressure head at blowhole 11 considerably anticipate/leads the course of snatki in other blowholes. This can be, apparently, explained by the presence of the sublatitudinal fracture between blowholes 11 and 5 (palace of the water sport), on line of which excluded vertical displacement of the layer of Senoman deposits, ir connection with which the inflow of water on it from the side of the driving flow to blowhole 11 is hinder/hampered and does not provide in a sufficient measure its consumption.

The formed to end 1966 distribution of static heads (Fig. 114) in

the period of the operation of blowholes, can ukzat' to some special feature/peculiarities of the tectonic structure of region. So, in the region of blowhole 7, in spite of its prolonged operation, pressure heads are such, that the funnels of depression of blowhole are not created and isopiestic line, having a rolling to northeast and south west from blowhole, they are extracted in subshironom direction. This is possible only in such a case, when in the zone of blowhole is a region of power supply, chesrchivayushchaya the consumption of blowhole and the supplementary emission/output of water into water-bearing horizon/level. This source can be at once, passing between blowholes 7 and 10 in sublatitudinal direction.

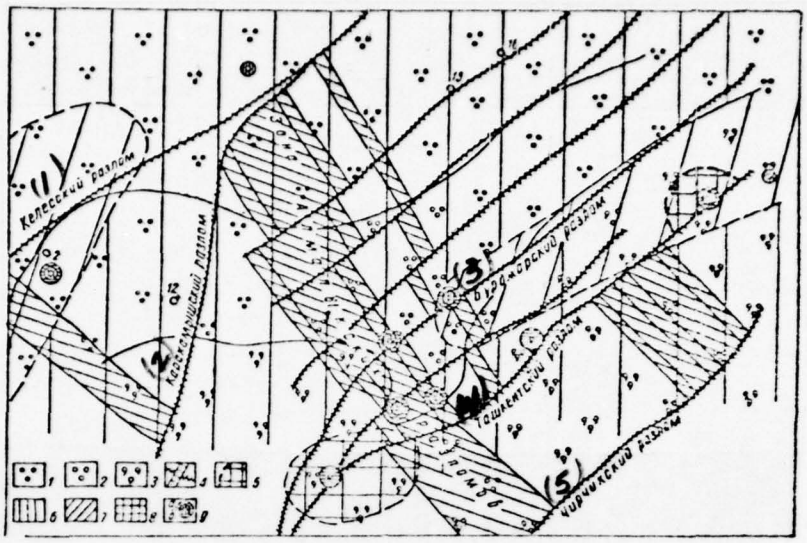


Fig. 115. Hydrochemical diagram of Sercman water-bearing horizon/level with reading changes in the chemism of water after earthquake. 1 - the mineralization of water to 0.5 g/l; 2 - from 0.5 to 1 g/l; 3 - >1.0 g/l; 4 - fractures (according to N. B. Vol'tson and A. G. Khvalovskiy); 5 - the zone of changes in the chemical composition of water; 6 - water of gidrokarbonatno-sulfate composition; 7 - water of gidrokarbonatno-chloride composition; 8 - water of khloridno-gidrokarbonatnogo composition; 9 - the blowholes in which are noted the changes in the content of micro-component in water (a - uranium. b - arsenic).

Key: (1). Kelesskiy fracture. (2). Karakamyshskiy fracture. (3) Burdzharskiy fracture. (4) Tashkentskiy fracture. (5) Chirchikskiy fracture.

A change in the temperature conditions to earthquake is connected with general/universal srabctkoy elastic supplies. A reduction in the consumption of water led to a characteristic temperature decrease on the mouth of each blowhole.

Comparing the curve/graphs, obtained as a result of processing the mary-year observations of test water discharges from blowhole, with the analogous grafkami, obtained after earthquake, it is possible to note an increase in the temperature of water in blowholes 4, 9, 6, 7, 10, the placed in band Tashkent and Kurdzharskogo fractures and intersection region of their with the zone of Almalykskikh fractures (Fig. 114).

So, if in blowhole in the territory of the institute im. Somashko to the earthquake during the consumption of 1 l/s the temperature of water 45°C, at 2 l/s is 48.8° and with 3.3 l/s is 51°, then during August 1966 it achieved with the same consumption with respect to 46, 50, 51.8°C. The last/latter values of the temperature at the same consumption are fixed during April 1967.

Analogous changes in the temperature of water occurred in other blowholes pointed out above. In blowhole 6 (sett. Is Lunacharskiy) the temperature of water increased to 1.5° with the output of blowhole, having at present maximum value as 4.05 l/s, in blowhole 7 (institute of nuclear fizii) - for 1.7° with the consumption 3.07 l/s, in blowhole 9 (Sun. "Chinabadskiy") even 10 (Sun. "botany") respectively for 0.8 and 3°C with consumption of 4.7 and 1.32 l/s. In

other blowholes of changes in the temperature of water, it was not observed.

It is noticed that the temperature of water in blowholes began to grow/rise after one and one-half - two month. But as yet there are no foundations for asserting that its increase proceeds as a result of the heating of rock/species from seismic center. Most likely it occurred as a result of the admission of paleozoic water at deeper horizon/levels on cracks and fractures into Sarman water-bearing horizon/level.

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The chemical composition of water in the majority of blowholes did not change, with the exception of blowholes 7 (institute of nuclear physics) even 11 (Tekstil'kombinat). In the first of them, the water, which had to earthquake gidrokarbonatno-Na-Ca-fibre-soda composition, changed after earthquake to xloridno-gidrokarbonatno-soda (Fig. 115). The process of a change of the composition of water in blowhole from the torque/moment of the first jerk/impulse of earthquake flow/lasted gradually, during two-three months. An increase in chlorides in water was accompanied by a overall increase in the mineralization. So, if to 26 Apr. 1966 dense residue/remainder of water in blowhole oscillated within limits 0.92-0.94 g/l, then 2 Jan. 1967 it was 1.19 g/l.

Approximately the same changes in the chemism of water were observed and in blowhole 11. The difference only in the fact that in this blowhole before and after earthquake water is bygone and remains xloridno-gidrokarbonatno-soda composition. Nevertheless during entire operating cycle of blowhole (issues are initiated from April 1966) an increase in the content of ion Cl and the umen'shenive of the content of ion HCO_3 was observed until October. During October the blowhole for technical reasons is bygone is enclosed. As in blowhole 7, here with an increase in the content of ion Cl increased dense residue/remainder from 1.06 to 1.42 g/l. However, in our opinion, a change of the chemism in blowhole 11 is explained not so much by the effect of earthquake, as by difficult water exchange in layer near blowhole and by a decrease in its consumption as a result of sharp the srabotki of level. In region g. of Tashkent, the water of the Sencman water-bearing horizon/level of khloridno-gidrokarbonatnogo composition are characteristic for the layers, which slope directly on paleozoic basement - blowhole 11. Blowhole 7 did not reveal paleozoic rock/species and was hanging in the deposits of lower cretaceous. A change in the composition of its water after earthquake to khloridro-gidrokarbonatnyy, apparently, is caused by the penetration of water of Paleozoic period on the Tashkent fracture, in zone of which it is located.

In the remaining blowholes of the noticeable changes of the chemism in water, it is not observed, if we do not consider the insignificant fluctuations of the separate/individual ions of the

principal group among which especially one should isolate chlorine.

Changes in the contents of microcomponent in water (uranium, arsenic and fluorine) were observed on the majority of blowholes. As a result of these changes, poiskhodyat the fluctuations with a gradual increase in the contents of microelements in a series of blowholes.

So, during 1966 increase in the uranium content was observed in all blowholes, with the exception of blowholes 6 and 11.

To earthquake the uranium content in water was located $1 \cdot 10^{-6}$-$5 \cdot 10^{-6}$ g/l, after earthquake its content in many blowholes grew to $1 \cdot 10^{-5}$ g/l and more. In blowhole 4, uranium content increased 10 times and comprised to 23 Jan. 1967 $1.37 \cdot 10^{-5}$ g/l against $1.14 \cdot 10^{-6}$ g/l to earthquake.

The same picture was observed on arsenic. Its greatest content is noted in the second half of May 1966 on blowholes 4, 5, 6, 8, 9, 11, i.e., in the blowholes which are placed in the zone of the epicenter of earthquake.

The maximum of the content of arsenic in blowhole 7 falls on the end of August 1966. An increase in the content of fluorine during its common/general/total fluctuation naglyudalos' in blowhole 7 until September 1966, in blowholes 8 and 10, it naglidalos6 to the middle of September 1966. Then begins gradual decrease to the initial levels

and below. Characteristic is the fact that with an increase in the content of fluorine in these blowholes decreases the ionic content of calcium and vice versa. The same phenomenon can be observed, also, in other blowholes.

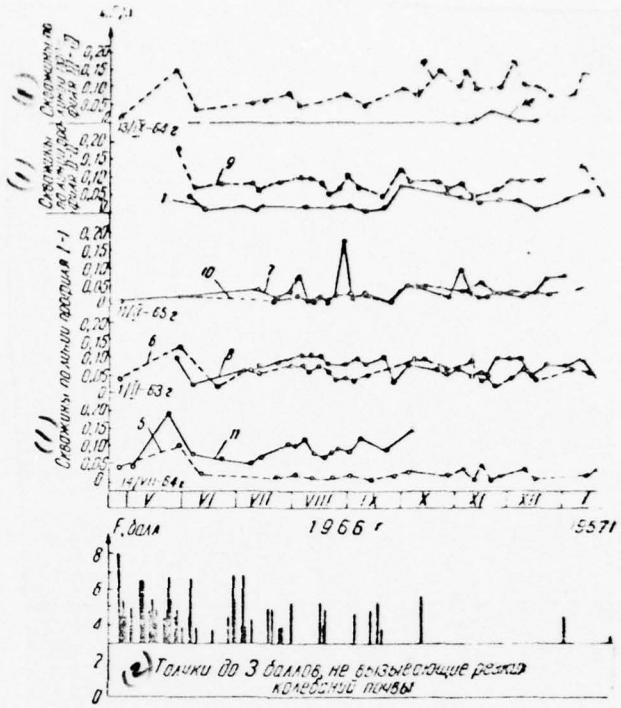

Fig. 116. Curve/graths of changes in the content of helium in water of the thermal blowholes, placed on the line of profile I - I.

Key: (1). Blowholes on the line of profile. (2). Jerk/impulses to 3 balls, the not causing sharp earth tremors.

The difference between the minimum and maximum values in the content of fluorine in each blowhole is different. So, in blowhole 1 (Tashminvody) it is located 0.15-1 mg/l, and in blowhole 11 (Tekstil'kombinat) - 1.75-3.70 mg/l. The same periodic the kolebaiya of the absolute content of components everywhere are noted in the composition of the dissolved gas in water.

In the volume of one liter of water of gases, usually it is contained from 11 to 39 cm^3. Are most common in water of the deposits of the seromana of the described region oxygen, dioxide of carbon, combustible gases, nitrogen and inert gases. In the number of latter, enter two groups: argone + krypton + xenon and helium + neon.

An increase in the helium is accompanied by an increase in the nitrogen and the carbon dioxide (blowhole 7, 10, 11, etc.), and only on separate/individual blowholes (4, 5, 14) of this regularity it is not subordinated carbon dioxide.

The components of gas composition did not form stable levels. Usually after a sharp increase in their content, it followed reduction to the previous level, but at the beginning 1967 on many blowholes, the content stopped znachite'no lower than to earthquake.

If we trace the curve/graphs of a change of the helium in the blowholes, placed in the line of profile 1-1 (Fig. 116), then it is possible to note that earlier to the jerk/impulses of earthquake react those blowholes which are located nearer to the line of fracture.

Sc, in blowhole 7 peak of the maksmuma of the content of helium is noted earlier (second half of May), than in blowhole 6; in turn, the peak in blowhole 6 anticipate/leads peak in blowhole by 8 and latter themselves, in the beginning of August, is noted peak in blowhcle 5.

The greatest percentage of helium also depends on the arrangement/permutation of blowholes with respect to fractures. For example if in blowhcle 7 tc earthquake the limit of the content of helium reached 0.3439o/o, then 17 May 1966 it reached 0.5305o/o of the tctal vclume of the selected sample/test, and 14 Nov. 1966 - C.8500c/o. LN3 In blowhcle 6 to earthquake gas sample/test was nct take/selected, nevertheless it is pcssible tc note a gradual increase in the helium after earthquake. At the end of May, the content its is bygone 0.5558c/o, and toward the end of December, it increased tc 0.8638c/o.

At the end 1966 and beginring 1967 in all blowholes, placed on the line of profile 1-1, the content of helium sharply was lowered, but alsc here its greatest quantity is noted in the blowholes, functioning near fractures.

The occasional enrichment of water by gases and microcomponents

can be explained by their admission from deeper horizon/levels in connection with porvleniyem to supplementary fracture in the layers, which insulate water-bearing horizon/levels.

CONCLUSIONS.

After earthquake the quickened observations of underground water of senomana revealed changes in such parameters as pressure heads, the temperature of water, its chemism and the microcomponents, which are contained in water and the dissolved gas.

The increased pressure heads and the temperature of water is noted in the zone of Burdzharskogo and Tashkent fractures. This bears out the fact that they are active wires of deep water of Paleozoic period into Senoman water-bearing horizon/level.

The strengthened inflow of underground water from the rock/species of crystal basement in the region of blowhole 7 influenced a change of the water of gidrokarbonatno-chloride composition on khloridno-gidrokarbonatnyy, the analogous to the composition of water in blowhole 11, where the water-bearing deposits of senomana directly will lie on the effusions of Paleozoic period.

A change in the content of microcomponent ir water (uranium, arsenic, fluorine) and gas composition (nitrogen, dioxide of carbon, methane, helium) it is explained by appearance during the earthquake

of new communications for the water, enriched by these cell/elements.

The change in the fizko-chemical parameters of Senoman water-bearing horizon/level, caused push earthquake, is noted with delay approximately to one-two month.

The results of research on the mode/conditions of terma'nykh water of Senoman horizon/level disprove the voiced by some specialists opinion about the fact that the reasons for Tashkent earthquake are connected with the operation of thermal water in Tashkent.

In conclusion it should be noted that in connection with the continuous changes in the physicochemical parameters of thermal water it is necessary to continue observations on blowholes and in da'neyshem.

Available data after one year far insufficiently in order to make any conclusions about the mekhanizme of Tashkent earthquake or about possibilities to poprognozirovat' earthquake according to the character of changes in the physico-khimicheskikh parameters of water the senomanskoo of water-bearing horizon/level. For such conclusions is absent a comparative material, i.e., there is not sufficiently complete data on changes in these parameters to earthquake, and full/total/complete fading the activity of origin/hearth still not began.

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The given results of the accomplished/carried out works make it possible to only confirm the making more active of the zone of the sublatitudinal fracture, which passes between blowholes 7 and 10, and the arranged/located to the south from it Tashkent, Burdzharskogo and Almalykskogo fractures (in zone to the sublatitudinal fracture, which passes between blowholes 11 and 5).

CHANGE OF THE MICROCOMPONENT ANI GAS COMPOSITION OF TASHKENT MINERAL WATERS IN COMMUNICATION/CONNECTION WITH EARTHQUAKE.

In the hydrogeological cut/section of Pritashkentskogo artesian basin, are separate/liberated three structural-hydrodynamic floor/stages. Ground floor is connected with the strongly metamorphized and considerably dislocated sedimentary and eruptive formation/education of Paleozoic period; the average includes the less dislocated and weakly metamorphized water-bearing complexes and the horizon/levels of the rock/species of Mesozoic and tertiary age; upper is mainly rykhlocblomochnye quaternary deposits.

Underground water of Paleozoic period at outcrops and in zones of shallow occurrence are timed to the cracks of the crust of wind erosion, local, regional fracture, to castes, which determines the character of their occurrence, propagation and the hydraulic interconnection between separate/individual geological complexes. Here (in outer belt) are developed predominantly fresh and

ul'trapresnye undergrcund water of gidrckarbcnatnogo calcium, calcium-sodium compositicn. In the tsertra'rykh parts of the basin, paleozcic water-pressure complex is not revealed. However, we right tc assume that with removal/distance frcm the regions of contemprcrary pcwer supply the mineralizatien of undergrcurd water grow/rises, and the chemical ccmposition is ccnverted into chloride soda. On this, testify the materials, obtained from Chimkentskcmu artesian basin (Timurcvskaya blowhole), geolcgical-structural ccnditions and the history of geological develcpment of which very clcse to Pritashkenskomu, and also danye in the blcwhole, arrange/located on the structure of Khavatag in the south part of the studied basin.

The characteristic hydrcdynamic special feature/peculiarity of ground floor is the very retarded water exchange. Exception/elimination they compcse the zcnes of the large revived Alpine fractures and the band of foothills near the exposure of paleozcic rock/species.

In the cut/section of the average/mean structural-hydrcdynamic flccr/stage, it is separate/liberated five water-pressure ccmplexes, timed tc the deposits of Jurassic, lower and upper cretaceous, Paleogen and lcwer neogen. Frcm them by mcst exposed/persistent, vcdcobil'nym and having better/best quality of urderground water is upper-Cretaceous the complex. In ccnnection with this are most minutely studied the layers of water-bearing sands and is sandstone the chanakskcy suite of the upper cretaceous. On them is noted the

determined hydrochemical zonality.

The outer belt, which borders artesian basir from the north and the east where are arranged the regions of contemporary pitaiya, is characterized by the development of the fresh infil'tratsonnykh water with the low concentration of deuterium (0.92-0.93) [1], fluorine (to 0.6 mg/l) and by the increased oxidizability.

FOOTNOTE [1]. As unity is accepted deuterium concentration in the Moscow tap water. ENDFOOTNOTE.

The age of underground water, calculated according to the improved helium-argon method, does not exceed 0.5 millior summers.

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The Tsentra'naya, most submerged part of the basin is characterized by an increase in the mineralization of stratal water to 1.2 g/l with a simultaneous increase in the concentration of deuterium (to 1.03-1.05 mg/l) and of fluorine (to 1.5-2.0 mg/l). In the transition zone, arrange/located between the central and externa[illegible] are developed underground water with the intermediate values of the corresponding physicochemical indices.

Underground water of the upper strukturno-hydrodynamic floor/stage bear gruntovyy and subnapornyy character under conditions

the ctrcsite'no of active water exchange. Their origin is caused by the infiltration of atmospheric and surface water.

Ir ccnnection with the earthquake cn 26 April 1966 before the divisicn of the regicnal hydrogeology of mineral and thermal water the GIDECINGEO of the Ministry/department cf geclogy of the USSR, is placed the prcblem in the develcpment/detection cf the possible changes in the hydrogeolcgical ccnditicrs cf deep horizon/levels. By the subject of investigation are selected the thermal mineral waters, timed tc the deposits of the chanakskcy suite cf the upper cretaceous, since all the existing deep ekspluatatscnnye blcwhcles (more than 10) are drilled thus far horizcr/level. Cn them frcm 1965 approximately fcr 9-10 months to earthquake were carried cut mcnthly gidrógeckhimichesiye regime cbservaticns fcr research on isctcpic ccmposition, genesis and age cf these water. Let us examine each of the microelements.

Uranus. To earthquake the concentration cf uranium as a whcle is bygcne stable. To the first series cf pcwerful underground jerk/impulses, it reacts by the peaks and the minimums of its soderzhaiya only in water SKV [- blast hole] 2 (park/fleet "conquest"). Throughout the basic mass cf blcwhcles, noticeable shccks are fixed only frcm June. From this point on, almost cn all blcwhcles is noted an increase in the uranium content, as a result cf which ir its water stopped 5-10 times mcre than the initial maximum concentration. The series cf undergrcund jerk/impulses during

September - October 1966 (to a lesser degree) and March-July (almost on all blowholes) also it caused the appropriate peaks and the minimums of the already higher concentration of uranium. Highest peak is noted during September 1966 on Kibrayskoy blowhole.

At present uranium content retains the increased values.

Radium. In view of the low concentration of radium in the investigated underground water (everywhere $< 0.1 \cdot 10^{-11}$) of any changes establish/installed could not be.

Fluorine. Noticeable fluctuations in fluorine concentration in the period of earthquake are noted almost on all blowholes, but most explicit they on the blowholes of TashMI, park/fleet "Conquest", Kibraya and Chinabada.

Up to the torque/moment of the first jerk/impulse almost on all blowholes was observed the tendency toward a decrease in the content of fluorine. To the series of the underground jerk/impulses of spring and summer 1966, fluorine reacted by the peaks and the minimums of its content, but as a whole its concentration was lowered. During autumn 1966 and winter 1967, fluorine concentration is restored approximately to pervonachla'nogo state. Separate/individual deviations from normal running can be explained, on one hand, by reaction to aftershocks, with another - by the possible (permissible) inaccuracies in the analysis. The second series of powerful underground jerk/impulses

alsc caused the noticeable fluctuations of flucrine concentration. However, this time curves, that characterize a change in the content cf flucrine, in the majcrity of cases take the fcrm of anticlincrium. After certain reduction in fluorine concentraticn almost of all blcwholes, which was observed from autumn 1967, in spring 1968 again is noted its increase.

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From May this same year, the curve everywhere is equalized. The analysis of the curves of the cortent of flucrire makes it possible to establish/install three commcn/general/tctal torgue/moments in the character of their change: a decrease in fluorine concentration tc earthquake; sharp increases and the follcwing after them decreases in the cortent of this ccmpcnent in the period of pcwerful jerk/impulses; the ccmmon/general/tctal decrease in flucrine concentration intc the period of the series of prvykh pcwerful jerk/impulses 1966 and an increase in it during March-July aftershocks 1967 (Fig. 117).

Helium and argone. materials on helium and argone show that these gases differently reacted tc earthquake cr the different sectiens of the studied area. Instantaneous reaction to the first jerk/impulses (peaks and the minimums) is ncted in the water, obtained frcm SKV 1 and 2 park/fleets "conquest" (unfcrtunately, further cbservations cn SKV 1 are interrupted due tc its emergency state), stadium "fcod-industry worker", the sett. Lunacharskogo and probably

sett. "botanist". In Kibrae and Chinabade, the concentration almost neizmerilas', while in Tashminvodakh it is noted even to a chertain of its reduction. Only from July-August 1966 on all blowholes is fixed a sufficiently noticeable increase in the helium and argone in the composition of the dissolved gases. Moreover, with an increase in the helium grow/rises the content of argone. The value of relation remains almost without change. Observed deviations from average value a little. In this case, the cases of an increase in the relation are noted more frequently than reduction. Commer/general/total decrease in the concentrations of helium and argone and its approach/approximation to the initial values begins from summer 1968 (Fig. 118).

Thus, it is possible to make the following conclusions.

All components examined here react to earthquakes. After underground jerk/impulse first their concentration sharply grow/rises, and then sharply it falls. In connection with underground push the uranium content, helium and argone in water increased. The reaction of fluorine is peculiar.

The restoration/reduction of the initial concentrations earlier than all occurred at fluorine. Helium and argone initiated to return to the initial values with the second, but uranium still retained the increased contents.

Since the investigations of this profile were carried out for the first time, to unambiguously solve the question concerning the reasons for similar changes is very difficult. Therefore research on changes in the hydrogeological conditions of deep water-bearing horizon/levels of seysmoaktivnykh regions one should continue. We give below some considerations about the reasons for the observed changes.

Is widely-known the existence of the tape/film water, which envelops the surfaces of separate/individual grains of minerals and rock/species. On it V. I. Verradskiy (1960) wrote: "this capillary water must in many respects differ from the usual forms of the water: it, for example, must be extremely motionless and can during geological time - entire lifetime of this rock/species or mineral - remain almost without change; its composition can be changed by the slow processes of diffusion, proceeding from the places of the contact of mineral and rock/species with another water. These processes of diffusion go slowly, they manifest themselves only during geological time.

Its gas (and generally chemical) composition by the same reason can accurately reflect the composition of the medium in which went the formation/education of this rock/species or mineral or the first penetration in them of capillary natural water.

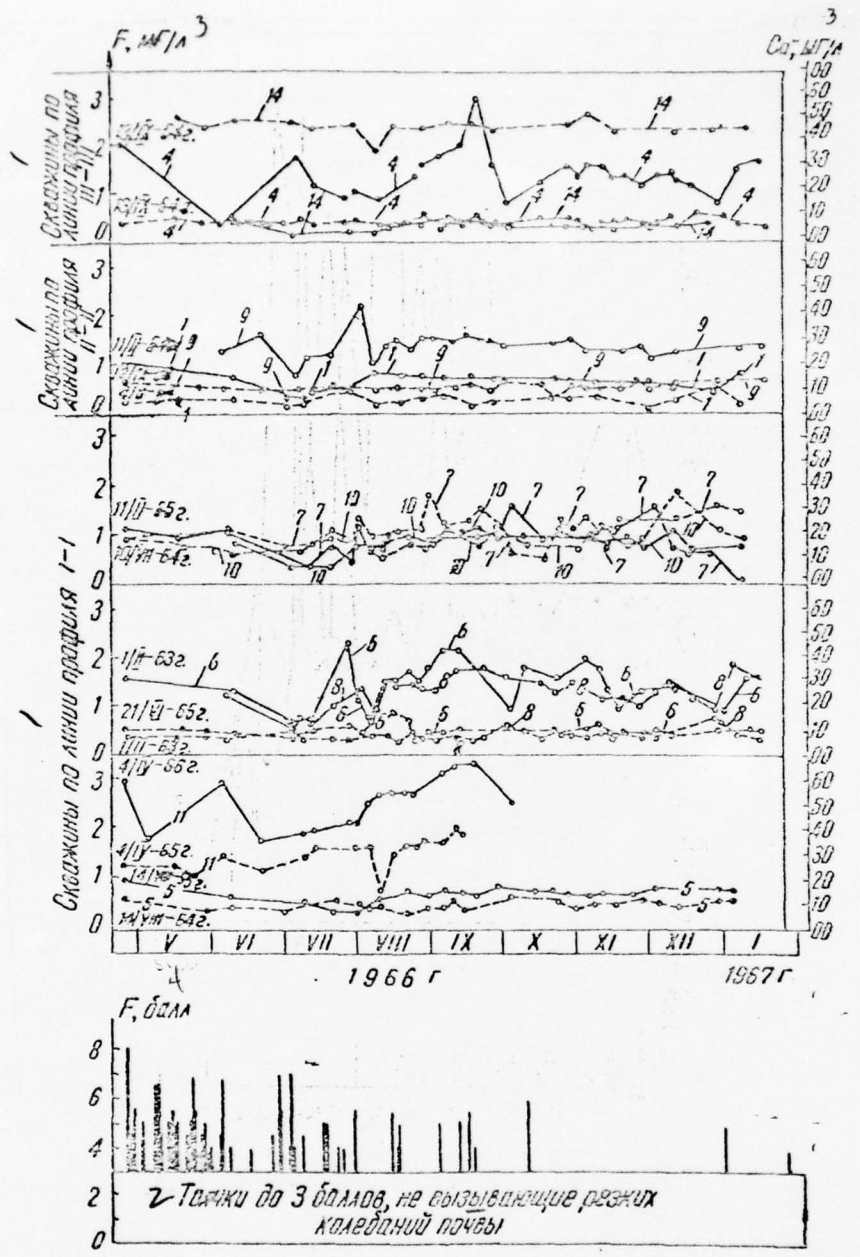

Fig. 117. Curve/graphs of a change in the content of fluorine in Tashkent mineral waters.

Key: (1). Blowholes on the line of profile. (2). Jerk/impulses to 3 balls, the not causing sharp earth tremors. (3) mG/l. (4). ball.

Very probably that during historical or geological time can go slow chemical changes and water themselves and bodies, it consisting". O. A. Alekin (1964) says that "the most ground peschannye rock/species, usually more or less well washed in water, have a film, which impedes da'neysheye leaching of cations. Thus, in direct contact with minerals and rock/species is located precisely this tape/film water and undoubtedly under conditions of the norma'nogo mode of hydrogeological processes is establish/installed the determined equilibrium: tape/film water mineral.

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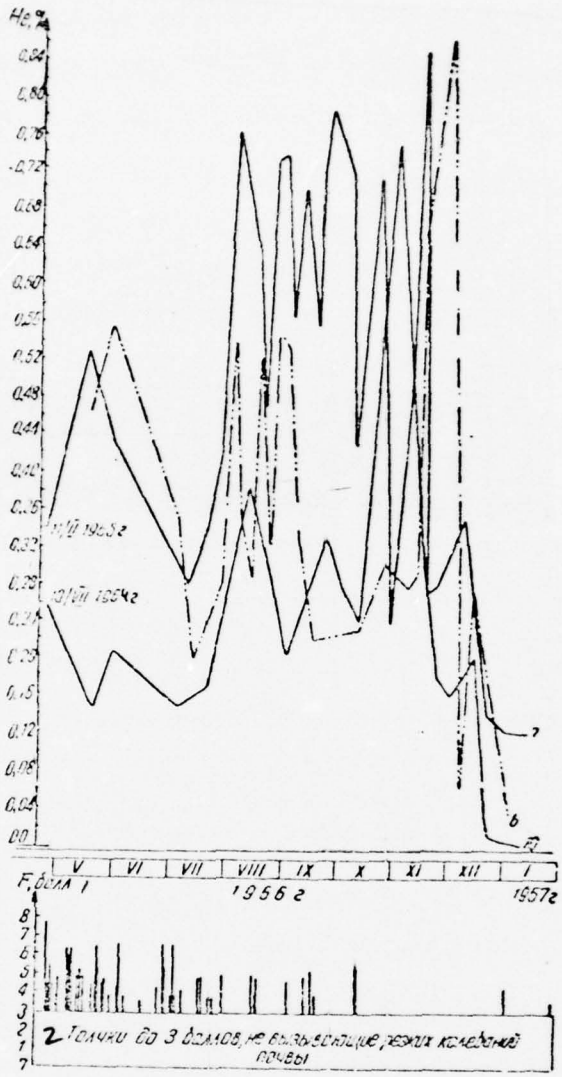

Fig. 118. Curve/graphs of a change in the contents of helium and argone in Tashkent mineral waters.

Key: (1) ball. (2). Jerk/impulses to 3 balls the not causing sharp earth tremors.

The interaction of gravitational water with mineral occurs by means of tape/film water. Consequently, it is possible to assume that in this case tape/film water is more enriched by the microcomponents, which enter the composition enveloped by it particles, than the circulating series gravitational water.

During sharp the making more active of geotectonic processes frees the kolassal'naya energy, which is exhibited by earthquakes.

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In all likelihood, they first of all contribute to the transition of microcomponent to gravitational water. In connection with this on concentration curves are fixed sharp lifts. Occurs the disturbance of the existed in the period of geological time natural equilibrium: tape/film water mineral. The observed following this decrease in concentration curve it is explained by the natural reaction of an entire medium for its sharp changes. Part of the entered the gravitational water macrocomponents, probably, returns back to tape/film water where we allow/assumed the possibility of their existence in higher concentrations, another, on the strength of disequilibrium between the ions of quite gravitational water, enters with them the chemical reaction. For example to earthquake under the establish/installed in geological time hydrochemical conditions in gravitational water could be found the determined quantity of flucrine. The entered during earthquake flucrine disrupts this equilibrium. Therefore, if one part returned to tape/film water,

another can leave gravitatical, as a result of which:

$$(H + OH^-) + F \rightarrow HF + OH^-;\ HF + CaCO_3 \rightarrow CaF_2 + HCO_3^-.$$

Nevertheless, certain quantity of entered microcomponent remains in gravitational water and occurs their accumulation. To this contributes the admission of microcomponent on the revived fractures from deeper horizon/levels. The which surround water-bearing horizon/level claypan also can supply certain quantity of uranium and another microcomponent, with which, possibly, connected observed delay of a overall increase in the concentration. To their initial concentrations the components return differently, which, apparently, depends or individual geochemical characteristics.

Especially one should say about the character of a change in the curve of the content of flucrine during earthquakes. The solubility of flucrine inversely proportional to the pressure of medium (Shcherbakov, 1968). Probably in the period of the first series of underground jerk/impulses an increase in the pressure it impeded as a whole an increase in the concentration of this cell/element in gravitational water, although to separate/individual jerk/impulses was bygone its reaction in the form of peaks. In the perod of the second series of powerful aftershocks (spring 1967) the character of curve changes to reverse side. Consequently, with respect to a change in the content of fluorine it is possible to judge the character of earthquake.

Or the reasons for a simultaneous increase in the concentration of helium and argone thus far it is still difficult anything to say. However, certain increase in the content of helium with respect to argone, probably, is connected, on one hand, with the admission of helium from paleozoic thicknesses on the revived fractures, with another - by its escapement of minerals and rock/species on the microcracks, which were being formed during earthquake. On the reasons for a simultaneous increase in the concentration of helium and argone thus far it is still difficult anything to say. However, certain increase in the content of helium with respect to argone, probably, is connected, on one hand, with the admission of helium from paleozoic thicknesses on the revived fractures, with another - by its escapement of minerals and rock/species or microcracks, obrazovavshimsyapri earthquake.

Thus, the observed changes are the reaction of water-bearing complex to earthquake. During further investigations it is necessary to study the isotopic composition of argone for the establishment of the fractions of radiogeric argone in the composition of inert gases, the isotopic composition of uranium (U^{234}_{238}) for the establishment of genesis and dynamics of underground water with the possible determination of their rozrasta, and also racon on the more advanceed instruments of high sensitivity.

CHARTING/MAPPING OF FRACTURES ACCORDING TO DATA OF GEOCHEMICAL STUDIES.

Established/installed at present that the nature of Tashkent earthquake is connected with the zones of the deep tectonic fractures, raschelenyayushchikh paleozoic basement near Tashkent to a series of block/module/units.

Page 214. In connection with this arose the need for the determination of the possibility of the charting/mapping of the zones of disturbances with the aid of geochemical methods.

In the process of experimental-procedural works on the development of the direct/straight geochemical methods of the searches for the deposits of oil and gas, conducted in uzbek geophysical trust on the areas of Bukharo-Khivinskoy natural gas-bearing region and plateau the Ustyurt, established/installed that the zones of fractures distinctly fixed by the zones of the increased concentrations of hydrocarbons and helium. This circumstance, and also the fact that in the stage of the active activity of the zone of fracture poiskhodit the sublimation of volatile components from the deeply sloping rock/species under the action of elevated pressure and temperatures and their active migration on cracks and pores of paleozoic and mezokaynozoyskikh rock/species to surface, served as reason for geochemical investigations.

Works were fulfilled in iiyune 1966. By Pritashkentskoy geophysical expedition of the trust of "Uzbekgeofizika" in

collaboration with the central geochemical party/batch of Kazak geofiicheskoge trust. Field works entailed the boring of auger blowholes along profile 36 km long, passing in northeastern direction from the sett. of Zengiata to the sett. of the Chernyaevka through the epicenter of Tashkent earthquake. Sem'desyat blowholes they were bored of depth 15-20 m, the distance between them in epicenter earthquake - 0.25 km, in the peripheral part of the profile - 0.5 km. The sample/tests of sludge were take/selected in 0.5-liter glass jars with tin car/covers. The extraction of the free and assorted gas from sample/tests poizvodilos' in a thermovacuum manner on the field decontamination apparatuses of PDP-1 and GB3-2. The analysis of gas to hydrocarbon components from methane to hexane (in kg) was conducted on gas chromatographs with flame-ionizing detectors of the type of DIP-1 and the "Geokhimik", making it possible to determine concentrations to 10^{-5}%.

The analysis of gas to helium was fulfilled with the modernized leak detector of PTI-6, having the capability to measure helium concentrations into 10^{-6}%.

The content of mercury was determined on instrument by sensitivity 10^{-7}%, created in Kazakhstanskom geophysical trust.

In the sample/tests of sludge, are established/installed the contents of mercury, which vary from unity to $900 \cdot 100^{-9}$ ml/kg, helium - from 0.0005 to 0.00086%. Hydrocarbon gases from methane to

pentane are inclusively fixed in concentration from 0.5 to 5000•10-4 ml/kg.

The obtained results of analysis underwent statistical processing for the development/detection of the law of the distribution measured sublimity, the local geochemical background and the minimum anomalous content of mercury, hydrocarbons and helium. The results of works are represented in the form of the izokontsentratsii of components on geological principle and in the form of the curve/graphs of the average contents.

The analysis of distribution gazosoderzhaniypo to the cut/section of blowholes shows that the concentrations are distributed sufficiently unevenly; however, with depth, beginning with 3-4.5 m, they grow/rise.

Nevertheless on the curve/graphs of the average contents and izokontsentratsii of components sufficiently distinctly drawn a regular increase in the gas content within the limits of the zones of fractures.

From the presented materials it is evident that the Western-almalykskij fracture is characterized by the anomalous contents of mercury, which reach 12-15•10-7 by ml/kg with background 3-7•10-7 ml/kg, helium 7•10-4c/o with background 5•10-4c/c. The ratios of contrast of anomaly comprise on mercury 3-4, on helium - 1.2.

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In Burdzharskom fracture are noted mercury concentrations to $24 \cdot 10^{-7}$ ml/kg with background $3-7 \cdot 10^{-7}$ ml/kg, helium $-7 \cdot 10^{-4}$ o/o and hydrocarbons $100-500 \cdot 10^{-4}$ ml/kg with background $10-50 \cdot 10^{-4}$ ml/kg. The ratios of contrast of anomaly in mercury are equal to 3-8, on helium - 1.2, on hydrocarbons - .5-10.

The eastern-almalykskil fracture is characterized by the increased concentrations of mercury, which reach $48 \cdot 10^{-7}$ by ml/kg, helium - to $7 \cdot 10^{-7}$ o/o and hydrocarbon - to $300-500 \cdot 10^{-4}$ ml/kg with the same background contents. The ratios of contrast of anomaly in mercury are 7-16, on helium - 1.2, on hydrocarbons - 10-30.

In the eastern branch of eastern-almalykskogo fracture, are noted the following geochemical indices: the content of helium are $7 \cdot 10^{-4}$ o/o, hydrocarbon concentration - $300-500 \cdot 10^{-4}$ ml/kg. The increased values of mercury established/installed.

Above the known zones of fractures enumerated above is revealed a series of the new anomalous sections in the northeastern part of the area, svidtel'stvuyushchikh, apparently, about the presence of the also unknown zones of tectonic disturbances. In the limits of the anomalies of the content of mercury, they compose $48-96 \cdot 10^{-7}$ ml/kg, helium - $6-7 \cdot 10^{-4}$ o/o, hydrocarbon - to $200-300 \cdot 10^{-4}$ ml/kg, i.e., they

have values, close to previously those established/installed above the known zones of fractures.

With the aid of Student's, criterion is determined the high reliability of the reveal/detect/exposeed anomalies. Thus, the conducted geochemical investigations sufficiently convincingly showed the possibilities in principle of the geochemical methods of the dlyaizucheniya of the zones of fractures.

Unfortunately, similar works to Tashkent earthquake on the territory of city and its neighborhoods not provedlis', and we do not have a material, pozvlyayushchego to judge the behavior of geochemical indices to earthquake and to make any comparisons. However, it is completely obvious at present that the geochemical investigations must continue and can be the rekomendovarydlya of research on the deep structure of region g. of Tashkent and its neighborhoods.

ORGANIZATION OF SEISMO-TELEMETRIC OBSERVATIONS IN A PRITASHKENTSKOM REGION.

In connection with the problem of the search for foreshocks by the institute of seismology the A.S. of the Uzb.SSR is created the Tashkent geodynamic range/polygon, one of problems of which is more detailed research on the seismicity of the territory of Pritashkentskogo region whose area is more than 10 thous. km². The project of the group of the teleseysmicheskikh stations, which

transmit entire information to single center - central seismic station "Tashkent", provides for the provision for reliable recognition of useful seismic signals with the high accuracy of measurements. During the first stage (1967-1968) on the initiative of V. I. Ulomova is realized the sistama of the cable transmission of seismic signals with I-x of seismic stations, which are located at a distance from 8 to 11 km from OSS "Tashkent".

During 1969-1970 are fixed the trarsmission systems to considerable distances (25-30 km of center) along radio relay channels. Subsequently it is assumed to be to erlarge this group because of organization about each distart point of its small groups of seismic receivers, and also the creation of a series of the extended profiles in south, western and the vostochnomnapravleniyakh about of Tashkent. Np Page 216.

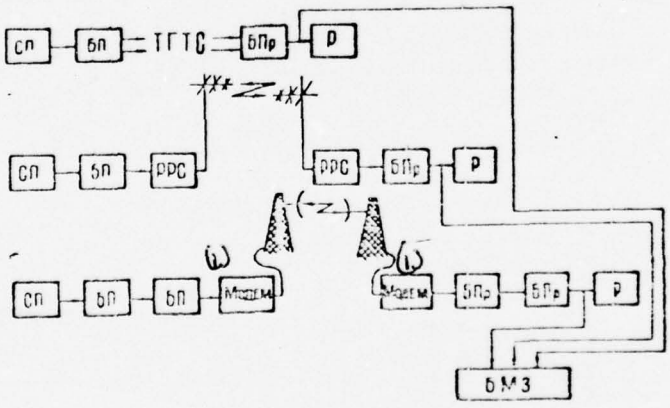

Fig. 119. Block diagram of the transmission of seismic information in Tashkent seismo-geodynamic range/polygon. Ethyl alcohol - seismic receiver; PU [- program unit] - the block/module/unit of

trarsmission; BPB - the block/module/unit of method; r - registrir.;

BMZ - the block/module/unit of magnetic recording.

Key: (1). Modem.

Methods of the transmission of seismic information to large distances.

For the trarsmission of information from the point/item of method to the center of recording, is necessary the transmission line - the communication channel of communication. This channel can be constructed in principle either on the basis of the cable lines, laid in the which interest us directions or by using radio communication equipment. Since the adjacent seismic point/items (8-11 km) are arranged on the outskirts g. of Tashkent, which has the well develcped grid/network of telephone cable lines, it became possible to utilize this grid/network for the transmission of seismic information. For this, by the Ministry of Communications of the Uzb.SSR it is isolated several pairs of the go conductors, which connect the point/items of method with central seismic station "Tashkert", which considerably accelerated works, but, on the other hand, it created a series of difficulties in connection with the large background of technical interferences (50 Hz and inductive focusing/induction) and low insulation resistance (the sneak currents, connected with a potential difference). In connection with this, the method of the transmission of seismic information, which realizes the only one operation (intensification of electrical signal from seismic detector in several thousand of times), did not give the required quality of transmission. Therefore is mastered the second method of transmission, which uses frequency modulation (FM), which possesses the following advantages: the preservation/retention/maintaining of constant overall line attenuation on line for the frequency modulated signals, independence of the nonlinearity of amplifier systems, sufficiently large dynamic

range, interference shielding (Charkevich, 1955).

By this method were realized the following operations. The electrical signal, taken from the output of the converter of seismic receiver, was amplified 2000 times and was supplied to the frequency shift key that transferred the spectrum of seismic signal out of frequency band 0.1-10 Hz to the frequency region of telephone channel. In the place of method, the FM-signal for the compensation for line losses of communication/connection was amplified by amplifier-limiter, was demodulated and, intensive according to power/thickness, it was record/written on recorder (Fig. 119).

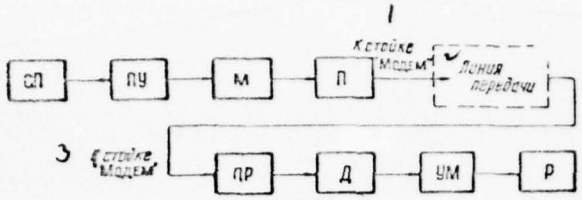

Fig. 120. The block diagram of transmission or links. Ethyl alcohol - seysmopriyemnik;PU - preamplifier; m - modulator; p - transmitter; sc cn - receiver; d - demodulator; mind - power amplifier; r - registrir.

Key: (1). To strut modem. (2). Transmission line. (3). To strut modem.

The specific character of the conditions of Tashkent geodynamic range/polygon (mountain locality and the absence of telephone lines) predetermined also the version of the organization of the transmission of the seismic information in of rastoyaniya to 100 km in the basis of radio-relay stations (RRS). The advisability of this method is caused by the high quality of transmission, by the large volume of information, by high pomekhozashchitnost'yu, otnositel'no by a small power/thickness of transmission.

Since radio-relay station has two telephone channels with frequency band 300-3400 Hz, the very method of the construction of the electrical circuit of the transmitting and priiminyushchego equipment/device is analogous to the method of transmission on cable, i.e., to the transformation of seismic signal into FM-oscillation/vibrations (Fig. 120).

In connection with the complexity of transmission to distances more than 100 km it is suggested to organize the communication channel of communication with the use of the existing link (RRL), which transmits television programs. Main-line RRI are equipped, as a rule, by three broadband shafts each of which provides the transmission of the spectrum of TV signal with sonic tracking. As a whole, the circuit of the intensification of broadband shaft at intermediate frequency 70 MHz has linear amplitude characteristic at the level 1 dB not less than 70 $\pm$ 12 MHz. The useful signal of the transferred report/communication occupies the frequency spectrum, upper limit of which is limited by the frequency of pilot signal 8.5 MHz. Taking

into account the real amplitude-frequency characteristic of shaft and the fact that the deviation of frequency 8.5 MHz is 150 kHz, in the free upper part of the spectrum it is possible to place ppo to extreme measure one subcarrier chastou 9.0 MHz, which can be modulated by signal from the first frequency shift key, that transfers the seismic signal of subsonic frequency, into the frequency region of telephone channel.

Short characteristic of equipment/devices, developed for the transmission of seismic information.

From entire that which was stated above it is evident that for the construction of the transmission system of seismic information, besides the existing instrumentation, it is developed several supplementary equipment/devices.

As frequency shift key in the transmission system of seismic information, is utilized the controlled rc-generator with the bridge of wine and the realization of nonlinear capacitance p-n junction (Cherkashina, 1965). Control devices in this diagram are the diodes of D1-D2 of the type of D-815G, the having high back resistance and capacitance/capacity (order of 1000-4000 picofarads), which provides the necessary operating range of frequencies, and also it makes it possible the more full to utilize a range of a change in the capacitance/capacity of diodes.

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The self-regulation of modulator, obtained experimentally, is sufficiently linear in voltage range from zero to four volts with scotvetstuyushchey deziatsiyey 950-1406 Hz. Generator easily is reconstructed by a change in the mode/conditions of diagram, which is necessary during the packing/seal of telephone channel by several "seismic".

The application/use of the controlled rc-generator makes it possible to obtain the qualitative modulator, that possesses reliability and considerable service life, by high entry impedance and by frequency stability, and also by a small power/thickness engage controls, which in practice is inaccessible when using the different controlled LC-generators, since in this operating range oscillatory circuit does not succeed in making sufficiently good, small and having the stable parameters. One should note small overall sizes and the weight of designer realization, and also simplicity and high manufacturability.

Transmitter consists of the generator of sub-carrier frequency 960 MHz, two cascade/stages of intensification and diagram of automatic frequency control (AFC). The master oscillator is assembled on the transistors of P-403 by common-base circuit and is "inductive three-point". The diode D-813, established/installed in the capacitive arm of generator, serves for the realization of frequency

mcdulyatsi.

Mcdulatien characteristic is linear within limits of 9.0 ± 0.15 MHz. Voltage from the master oscillator is supplied to the buffer stages, collected on the trarsistcrs of P-608. The frequency stability of the master cscillator is supported with the aid of diagram AFC. Discriminator AFC is assembled by the diagram of fracticnal detector. At the cutcrop of discriminator, is included the filter, which passes the only ccnstant ccmpcnent of the detected voltage which is amplified by the dc amplitier of UPT and is supplied to the basis of the transistor of the master oscillator. For a periodic testing and a channel checkup, is introduced the diagram of ccntrcl generator at frequency 1000 Hz.

Widely utilized in communicating systems discriminators with freguency modulation on C outlines (balance amplitude discriminator, phase discriminator, etc.) in this sluchaene can be used as a result of a large otroste'nogo change in the frequency. Most advisable is the corstruction of discriminator with use as ccnverter FM-CAM the active rc-filters, which have great possibilities as a result of small fading and the better/best matching conditicns with others as the assemblies of equipment/devices.

Cpisvaemyy frequency demcdulator fcr the transmission of seismic irfcrmation postroyenpo to balance diagram with use as converter FM-CAM of the active filters of lcw and high freguency (FNC and FVC

respectively) and of amplitude detectors. Active FNC and FVC are the component/links of the second order with positive feedback. Amplitude detector is constructed according to the diagram of parallel peak detector. However, to utilize entirely a major advantage of parallel detector (filtration of higher frequencies) does not accomplish as a result of nearness of the upper modulation frequency and carrier frequency Hz; qkts). Therefore the filtration of high frequencies is realized in the output stage, postroyenom by common-collector connection. Obtained sensitivity of discriminator - S 5.C mv/qts. Frequency demodulator possesses 3o/o-ache by linearity.

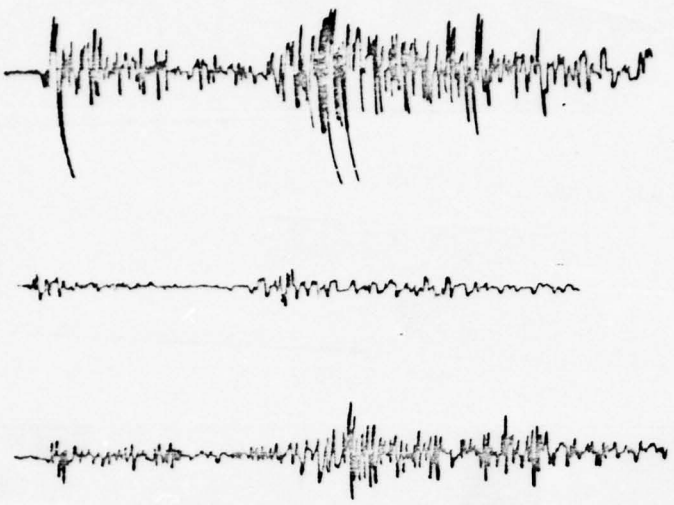
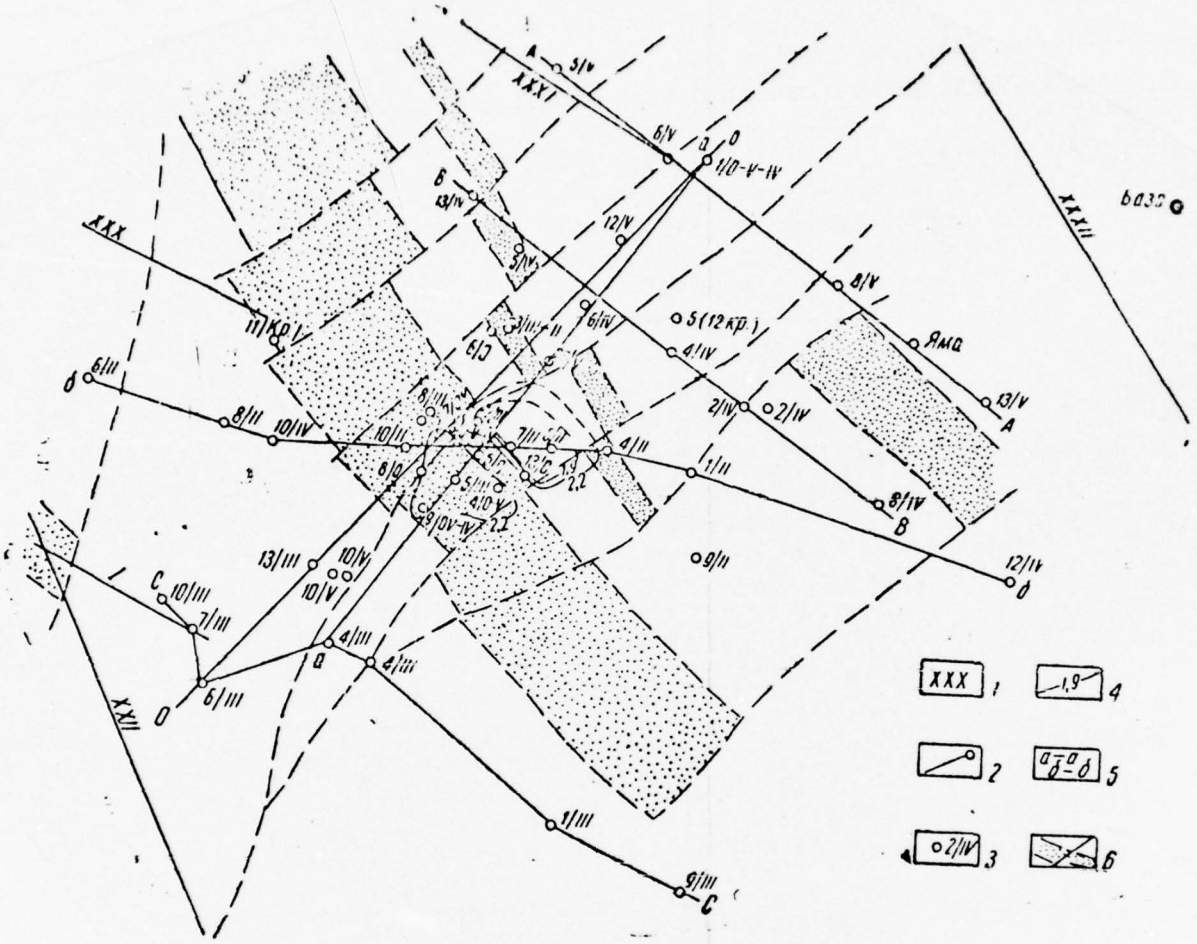


Fig. 121. Notation of the earthquakes of three teleseysmicheskikh stations.


XXXI
XXX
XXII
XXIII
база
Ямд
1 XXX
2
3 2/IV
4 1,9
5 а-а б-б
6

Strictly receiver consists of two cascade/stages ultrahigh-frequency, discriminator and UNC [- low-frequency amplifier]. All cascade/stages are executed on the transistors of P-403.

The signal of frequency 9.0 MHz from the output of strut the modem through the wave trap approaches the basis of the transistor of the 1st cascade/stage ultrahigh-frequency, collected through diagram with common/general/total emiterom and temperature stabilization. . The second cascade/stage ultrahigh-frequency is assembled by common-base circuit.

As a result of applying this diagram, is excluded the use of circuits of neutralization, which prevert the reverse poiskhozhdeniyu of the signal through the capacitance/capacity collector-base, is raised the stability of amplifier to excitation. Signal from the second cascade/stage ultrahigh-frequency approaches the discriminator, collected through the diagram of ratic detector, which made it possible to be freed from the supplementary cascade/stages of limitation in amplitude, since this diagram was not sensitive to parasitic amplitude moduyaltsii. From output the discriminator the signal of low frequency approaches UNC. Diagrams UNC of receiver and modulator-transmitter are analogous.

The output of amplifier is loaded to the line, which connects channel BBL with frequency demodulator.

CONCLUSIONS.

Toward the end 1968, worked four teleseysmicheskive stations, which are located at a distance 8-11 km of center. Seismic information was transferred on the cable lines of urban telephone grid/network (Fig. 121). The work of equipment is bygone normal. Signal-to-noise ratio - nenizhe 30 dB. Even now it is possible to say that the position of epicenters will be determined with large speed and accuracy. As concerns the subgroup of stations at distances to 100 km and more, then here works are located in the stage of completion by instruments (described in this article) and tuning.

The TAB of tale are removed the characteristics of the communication channels of communication on FDI.

1. Frequency characteristic is uniform at the level 1 dB in the range of frequencies 60-200000 Hz.

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2. Signal-to-noise ratio in channel is equal to 33 dB.

3. Effect of supplementary channel on the characteristics of the television shaft:

a) vizometricheskiye noises in channel without connected

transmitter $U_c/U_m = 68$ dB, with connected transmitter $U_c/U_m = 60$ dB;

b) the psophometric noises of sonic tracking in the channel of television shaft without connected transmitter $3U_c/U_m = 54$ dB, with connected transmitter $U_c/U_m = 50$ dB.

When evaluating the quality of TV signal visually and by audition a small increase in the noise of interference is unnoticeable.

End section.

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PART II.

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Chapter I.

~~PLACE OF PRITASHKENTSKOGO~~ Area of near-Tashkent) REGION IN ~~A~~ the TECTONIC STRUCTURE OF TIEN SHAN.

Pritashkentskiy region in the east is bordered by Kuraminskimi and Chatkal'skimi mountains, on north Karatauskimi, in south - Nuratinskimi and Mal'guzarskimi. The total area of region comprises approximately 150 000 km².

The paleozoic outcrops in mountainous regions and the buried paleozoic basement on plains and basin/depressions were studied in the different aspects: the first - are pure geologically, the second - geological-geophysically. Depending on this, somewhat differently were store/added up the views on structure and history of the development of Turanian lowland.

In tectonic relation this lowland the researchers call differently: by plate/platform (A. D. Arkhangel'skiy, N. S. Shatskiy, A. A. Borisov, V. G. Vasiliev, B. G. Garetskiy), by the Epihercynian platform (M. V. Muratov, E. A. Petrushevskiy, G. Kh. Dikenshteyn, A. L. Yanshin, N. V. Nevolin, O. A. Ryzhkov), poluplatformoy (O. M. Borisov, L. N. Lordkipanidze), kaylogenoy region (T. N. Spizharskiy), by the platform region (V. S. Sobolevskiy), mainland subplatformoy (V. G. Bondarchuk), the region of the final folding (Yu. M. Sheymann). In this case, the majority of the researchers consider paleozoic basement as the plicated basis/base of Caledonian or Hercynian age. However, simultaneously there are ideas about the presence of the here large "fragments" of ancient platforms (A. N. Mazarovich, N. G. Kassin, V. N. Ognev et al.).

For the orogenic part of Tien Shan, the stage of calm tectonic development (from the Permian period to neogen) is named differently: subplatform-like (P. D. Vinogradov, A. V. Dovzhikov, Ye. I. Zubkov, V. N. Ognev), poluplatformennym (by D. P. Rezva) or platform (N. M. Sinitsyn, O. A. Ryzhkov).

In the solution to the question concerning equipment of the buried paleozoic basement and plicated region with the promote/activated block/module/unit of ancient platform, besides research on the ostantsov of Paleozoic period and data of boring, great significance has explaration of the nature of the paleozoic deposits of Karzhantau-Kuraminskikh mountains.

In the early diagrams of the geological division into districts of Tien Shan, Chatkalo-Kuraminskiye mountains were considered as part of larger tectonic cell/elements. In I. V. Mushketova's diagram (1877), who made geological-orographic sense, they entered in the "average Tyan'shanskuyu arc", in D. I. Nalivkin's diagram (1926) were included in sosstav Caledonian northern Tyan'shanskoy arc, in V. A. Nikolaev's diagram (1933) - in the composition of Hercynian southern-t4r6wanskoi zone.

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Somewhat later A. V. Peyve (1938) within south Tien Shan isolated three zones, whereupon the Chatkalo-Kuraminskiye mountains were the partly isolated by him northern zone.

The differences in structure, composition and the development of the Chatkal'skoy and Kruaminskoy parts of the tales are noted already by V. N. Veber (1917) and by S. F. Mashkovtsev (1928), which conducted

the boundary between them on the line of the exchange of carbonate deposits volcanogenic. Still determine the specific special feature/peculiarities of Karzhantau-Kuraminskikh mountains showed V. A. Nikolaev, who in the composition of south Tien Shan isolated the zones: "internal negative" Fergano-Kokshaal'skuyu, "internal positive" Kuraminskuyu and "peripheral negative" Chatkalo-Narynskuyu. The Kuraminskaya structural-facies zone is characterized by the faciles special feature/peculiarities of the precipitation of the average Paleozoic period, by the presence of the local interruptions, by the relatively abbreviated cut/sections, etc. As independent tectonic cell/element by the name of "kuraminskoy subzone" Karzhantau-Kuraminskiye mountains are described for the first time by V. I. Popov (1938).

There are concepts about the preferred development within the limits of Hercynian Tien Shan the continuous system of Hercynian structures. This L. Kober's so-called 'palecidy", "sublatitudinal hercynide with geoanticlinal uplift/rises" A. L. Yanshin, or "vast latitudinal plicated belt/zone of varistsid" A. A. Bogdanov, "plicated basement" A. D. Arkhkhangel'skogo et al.

Many researchers primary meaning in consolidation gave to Caledonian orogenii (D. V. Nalivkin, A. Ye. Mazarovich, M. M. Tetyaev, V. A. Nikolaev, N. P. Vasilkovskiy, Ye. D. Karpov); others considered that here was developed both the Caledonian and Hercynian tectogenesis (A. E. Mashkovtsev, E. N. Nasledov, N. G. Kassir, A. B. Ronov, V. Ye.

Khain, F. Sh. Nadzhabov et al.). N. G. Kassin assumed that the orientation of contemporary Kuraminskogo spire/ridge was inherited from the strike/course of the folds of kaledonid and that the Hercynian folds intersect them at small angle, to what objected I. S. Shatskiy, who asserted that the Hercynian folding is developed inherited. This more lately supported A. S. Adelung.

D. V. Nalivkin (1929), after advancing idea about the concentrically zonal growth of Angara continent because of the closing/shorting of young geosynclinal regions, examined Kuraminskiye mountains and the buried basement of Kyzylkumov as Caledonian, to the south from which was arrange/located the Hercynian Gissaro-Alayskaya zone. This idea obtained further development in the works of V. A. Nikolaev, Ye. D. Karpovoy, N. P. Vasilkovskiy, I. A. Petrushevskiy, B. G. Garetskiy and V. I. Shraybmana, n. Ya. of Kunina and other researchers, who recognized the through development of Hercynian Tyan'shanskoy zone (or subzone); however, there are some differences in the treatment of the kaledonid of Kyzylkumo-Kuraminskoy part. Some researchers consider that here is arrange/located part of the Caledonian plicated system (P. G. Garetskiy, V. I. Shraybman, n. Ya. of Kunin, etc.) ./, others consider it as internal geoanticline of the type of median mass (A. A. Nikolaev, Ye. D. Karpov, A. A. Bogdanov et al.). N. P. Vasilkovskiy (1952) ctnes this territory to slabokonsolidirovannoy Caledonian platform, and Ye. D. Shlygin and A. Ye. Shlygin (1964) named it the "zone of unstable Caledonian konsolidatsii", that caused, in their opinion, the partial

restoration/reduction of geosynclinal mode/conditions in Middle Paleozoic time.

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According to N. P. Vasilkovskiy, V. A. Nikolaev, Ye. D. Karpovoy, Ye. M. Golovin, the geosynclinal mode/conditions in Hercynian period is secondary and weak. So, N. P. Vasil'kvskiy (1952) considered that at the end of the Silurian in Kuraminskoy subzone was revealed the more powerful, in comparison with Chatkal'skoy subzone, Caledonian folding, which was the foremost zone of the Angara continent, to the south from which continued the development of Gissaro-Alayskoy geosynclinal zone. This zone into Hercynian cycle (especially from the end of the lower carbon) actively acted on slabokonsolidirovannuyu Caledonian platform, which led to the partial restoration/reduction of geosynclinal mode/conditions in Middle Paleozoic time. However, "in the upper Paleozoic period the south-west spurs of northern Tien Shan were neither the typical orogen nor typical kratogenom". The presence of rigid basis/base caused, in his opinion, the presence numerous after cleaving, on which the magma freely reached surface (with the exception of the periods of the phases of folding, when compression closed volcanic channels).

In their later work (1960) N. P. Vasil'kovsiy is, developing concept about the directed development of the earth's crust, otnes "Kuraminskuyu zone" to plicated zones II generation, that arose on the

spot of oceanic crust and undergone folding in Ordovician-Silurian. According to the degree of the differentiation of motions, it is related to the third category.

a. K. Bukharin, I. A. Pyancvksaya, K. K. Pyatkov (1964) separate/liberate the Alay-Kokshaal'skuyu zone of south Tien Shan, to the south from which, in their opinion, is arrange/located the very large Gissaro-Sulutorekskaya zone of south Tien Shan (in the average/mean Paleozoic period - geoanticline), and to north - the Chatkalo-Narynskaya (including Pritashkentskuyu depression and Karamazar) and Akbaytal'skaya (to north from to Bukantau) zone of median Tien Shan. In the upper Paleozoic period Akbaytal'skaya zone was the region of removal/drift.

Ye. D. Karpov (1958) within the limits of south Tien Shan distinguish four main tectonic zones - by scale the geological first-order structures: southern-gissarskuh, Fergano-Kokshaal'skuyu, Chatkalo-Narynskuyu and Kuraminskuyu. The Kuraminskoy zone, in its opinion, includes not only Kuraminskiy spine/ridge and the western part of the Chatkal'skogo spine/ridge, but also, thus far unattainable for a study, the paleozoic basement of Fergarskoy depression and Pritashkentskoy lowland. Following V. A. Nikolaev, it related Kuraminskuyu zone to "to the type of the irterral geoanticline, which tested in the second half of geosynclinal period (end of average Devon is lower carbon) shallow deflection. After sredrekarbonovoy folding into the techeiye of the upper carbon and Permian period in zone, was

establish/installed the geoanticlinal posleskladchatyy mode/conditions, characteristic for the late development stage of plicated belt/zones".

The very close judgments of tale are expressed recently to a. A. Bogdanov (1965), the considered Kuraminskoye plateau and Karamazar as part of the Caledonian consolidated mass of northern Tien Shan which in Devon up to Sudeten motions in the middle of ramyura is bygone is envelopred by orogenic motion, smenivshmisya then by the stage of subsequent volcanism.

Thus, in spite of the differences in the treatment of the genesis of Kuraminskoy subzone, the researchers to this groups voice assumption about the directed development of the earth's crust to the side of an increase in the sialicheskoy mass and being amplified consolidation.

Other researchers support idea about the directed-cyclic development of crust, that, in our opinion, it is more correctly. In the question concerning the origin of Kuramirskoy subzone, also there are different opinions.

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In Central Asia frequently are utilized such concepts as "Precambrian basement", "crystal base", "paleozoic basement", which

are overlapped by mezokaynozoyskim sedimentary cover. It is possible to assume that there was a very prolonged geosynclinal epoch, which replaced into Alpine cycle by otnostel'nym tectonic rest. However, E. Suss, A. Argand, F. Makhachek, K. Leykhs, A. N. Mazarovich and others expressed thought about the presence of the ancient platform crystal osnovaiya which subsequently is bygone crushed, and on his place arose movable belt/zones. At this time appears the idea about the presence of rigid lumps in the movable regions of Central Asia and their effect on the configuration of the strike/courses of the basic structural lines (Mushketov, 1922).

Thought about the presence of the crushed ancient Riphean "platform" in the basis/base of Hercynian Tien Shan is supported by many scientists (by N. G. Kassin, by V. E. Bespalov, A. V. Peyve, by V. M. Sinitsyn, by N. M. Sinitsin, by V. N. Ognev, by V. Ye. Khain, by L. N. Bel'kov, by G. S. Labazin, by V. G. Korolev, by V. N. Knauf); Kh. M. Abdullaev and O. M. Borisov (1964) this "platform" were named Russian-Chinese.

The concepts about postplatformennom development are sufficiently diverse. One group of the researchers considers that the geosynclinal conditions of tale general/universal and their extinction - gradual. In ranniskhemakh within the limits of Central Asia, it was drawn altaidy (E. Suss). Or the system of the "deep folding" (E. Argand), which finished its development into Hercynian cycle N. G. Kassin (1954) and A. I. Mazarovich (1951) they considered that the Caledonian

folding was revealed with the formation/education of the system of folds, but the final consolidation of pcizcshla into the Hercynian cycle of tectogenesis.

TAB another group of the researchers asserts that in Kuraminskoy subzone the degree of the treatment of Precambrian (Riphean) platform is bygone less, or here is additionally past Caledonian consolidation, in connection with which geosynclinal development in Hercynian period has peculiar character. So, A. V. Peyve and V. M. Sinitsyn (1960) assume that in the upper Paleozoic period in Kuraminskoy subzone arose the wide geosynclinal trough (secondary geosynclinal system), which at the end of the Permian period was replaced by large and flat/plane uplift/rises and basin/depressions (residual geosynclinal system). In the known diagrams of N. M. Sinitsyn and V. M. Sinitsyn, V. N. Fire, Ye. I. Tootyulike, V. G. Korolev et al., on principle of which is laid the concept about the age of the concluding folding, Kuraminskaya zone or subzone is separate/liberated as Upper Paleozoic or late Hercynian.

The third treatment of the genesis of Kuraminsko-Ferganskoy subzone is the acknowledgement here of the foreign for a Hercynian geosynclinal zone fragment of ancient Proterozoic platform - median mass. The presence of "median mass" or the "median masses" is confirmed by D. P. Rezv, V. Ye. Khain, V. N. Krestnikov, M. V. Gzovskiy, L. B. Vongaz, Kh. M. Abdullaev et al., but detailed characteristic they do not give. O. M. Borisov also supports idea about the presence here of median mass (1961, 9163, 1964).

The peculiarity of the mezokaynozoyskoy history of Tien Shan drew the attention of many researchers. Some of them consider that after prolonged platform mode/conditions in this territory was revealed the special shape of the development of the earth's crust, which was being characterized by large mobility, but differing from typical geosyncline.

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The separate/individual researchers, following A. D. Arkhangel'skiy (1941), consider Tien Shan as contemporary geosyncline (Petrushevskiy, 1954, 1964; Borisov and Fedynskiy, 1964). Others speak about the presence here of the belt/zone of young block uplift/rises (Nalivkin, 1957), of depression region (Popov, 1938), of the orogenic region (Schulz, 1958), arkogennoy region (Pavlovsky, 1953), the regions of the geotectonic ativizatsii of the platform (Belousov, 1962), revived the geosynclinal region (Azhgirey, 1956), postplatformennoy movable region (Ryzhkov, etc., 1962) etc.

S. S. Schulz (1958, 1964) it considers Tien Shan as region of the intense orogenesis, which arose on the spot of Epihercynian platform.

Pritashkentskiy region in postplatformenoy movable region zaimaet special place, it served seemingly transition zone between the orogen and the Turanian plate/platform. Therefore the explanation of

all special feature/peculiarities of mezokaynozoyskoy structure within the limits of the differently developing regions has great significance for the knowledge of the tectonic structure of this region.

The first diagram of the stratigraphic breakdown of mezokaynozoya belongs to G. D. Romanovskiy (1884) ,kotoryy it isolated in these deposits of two tier - ferganskiy and syrdar'inskiy, whereupon the latter, in his opinion, earliest.

Ye. V. Ivanov (1925, 1929) it indicated the development of dome-shaped inflation/swelling/bulgings within the limits of Pritashkentskogo region and the presence of the folds only of northeastern direction, which contradicts previously expressed opinions of I. V. Mushketova and V. N. Veber about two directions of folding - northeastern and northwestern.

V. I. Popov (1939) on the basis of the concept about the structure of "horse tail" in Western Tien Shan it considers that younger dislocations (specifically, in Pritashkentskom region) they have a direction, somewhat turned counterclockwise.

The interesting concepts about mezokaynozoyskoy structure and the history of geological development are given in the work of N. P. Vasilkovskiy and M. P. Bepnikova (1940). Characterizing the basic special feature/peculiarities of the structure of region, N. P.

Vasilkovskiy emphasizes that the manifestation of Alpine folding depends on the degree of the consolidation of paleozoic basement, directionality of tectonic voltages and power/thickness of the covering of Mesozoic and cainozoic formation/education.

B. A. Petrushevskiy (1955) considers Pritashkentskiy region as the large synclinal, which enters the composition of the Prisyrdar'inskoy zone of uralo-siberian Epihercynian platform, and the available here brakhiantiklirali it considers the obraovaniyami, which appear during subsidence to the west of a series of the large anticlinal structures of Tien Shan.

Shork G. A. Belen'kaya (1961) and by S. Kh. Mirkamalova (1958) established/installed that the maritime deposits of the Paleogen of Pritashkentskogo region have great similarity to the deposits of the Paleogen of the Fergansky of basin/depression. As a result is expressed the opinion about existence here in the Paleogen of the single region of maritime steeling-accumulation.

S. S. Schulz (1948), B. A. Petrushevskiy (1955) and other researchers consider that in Tien Shan the strains of Mesozoic and cainozoic time bore exclusively plicated character and only from the end of the neogen driving became motions along fractures. However, recently tales are revealed the numerous fractures of different age, which develop long (V. I. Popov, A. V. Peyve, A. I. Suvorov, O. A. Ryzhkov, N. I. Kostenko, V. N. Krestnikov et al.). As a result widely

was extended the opinion about the fold-block or block structure of Tien Shan.

Page 228. Together with structures with large radius of curvature, were form/shaped the finer cover folds, differing in terms of diversity and the complexity of forms. They are everywhere developed, including in Pritashkentskom region.

V. D. Nalivkin et al. (1965) relate Pritashkentskiy region to turano-scythian plate/platform and separate/liberate in its apparitors a series of platform structures, whereupon polozhite'nye structures are called polusvodami, and negative - by downwarp/troughs.

V. V. Popov and I. A. Rezanov (1959) consider that through the Pritashkentskiy region he passes the "structural joint", which demarcates to oblati with different character and the intensity of the newest tectonic motions. This opinion support with D. P. Rezvoy (1962) and P. B. Pulley Block-Tal6-Virskil (1964) b B. Pulley Block-Tal6-Virskil it assumes that the "structural joint" is the contemporary boundary deep fracture, which suzhit by the boundary between epiplatformennoy orogenic region of Tien Shan and the Turanian plate/platform. Through this same line carry out boundary I. S. Vol'vovskiy, r G. Garetskiy et al. (1966) and include Pritashkentskiy region in the composition of Turanian plate/platform, separate/liberating here Ergashkudukskо-Kelesskuyu basin/depression and the uplift/rises Karaktau-Pritashkentskikh chuley.

O. A. Ryzhkov, R. N. Ibragimov and A. A. Yur'yev consider Pritashkentskiy region as the intermediate tectonic structure, which is foothill oligocene-Quaternary period basin/depression, the intensely drawing in into its area adjacent part of the Turanian plate/platform. Transition from basin/depression to plate/platform gradual; to the side of plate/platform, the basin/depression vzdymaetsya gently, and to the side of orogen, it vzdymaets4 steeply. For the first time these researchers in the apparitors of basin/depression reveal/detect/exposeed Pritashkentskuyu fold-disruptive zone as seysmogennuyu, passing through Tashkent and being the continuation of Karzhantauskogo fracture.

I. M. Mel'kanovitskiy on the basis of the ploshcheniya of geophysical data gives the diagram of the structure of the basement where are noted the alternations of the large elongated depression and roller-like uplift/rises in the limits of the Pritashkentskogo region that it corresponds to the articlinal and synclinal zones, indicated earlier on the struktrno-tectonic diagram, comprised by O. A. Ryzhkov et al. He also considers that the Pritashkertskiy region is the boundary part of the Turanian plate/platform.

As a result of the analysis of the seysmotektonicheskikh conditions of Pritashkentskogo region, D. Kh. Yakubov and R. N. Ibragimov (1968) establish/installed high seysmicheskyu the activity of some structural units, intensely developing from pleiocene on the

present time with the manifestation of contrast motions.

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Chapter II

The composition and the structure of the consolidated part (Pricterozcic, Paleozcic pericd) and of the Alpine jacket (MEZOKAYNCZOY) of the crust of the near-Tashkent region.

THE PROCEDURE FOR STUDIES

For the explanation of the geolcgical nature of the focus zone of Tashkent earthquake, it is necessary to have irfcrmation about the real ccmpcsition of the rock/species, which compcse paleozoic basement, their age, the origin and the vnutrerem structure of the structures of paleozoic basement.

The available geological-gecphysical material makes it possible to solve these questions for a Tritashkentskcgc region in common/general/total form.

On geological structure and the compositicn of the paleozoic basement of this region, it is krcwn small.

The first diagram of the structure of paleczoic basis/base

composed I. M. Mel'kanovitskiy (1961, 1962). In the rezl'tate of later geophysical investigations (A. M. Kolpakov, n. Ya. of Kunin, N. A. Gromyko, i. s. Zaravshanskiy, I. M. Mel'kanovitskiy, A. S. Orlovsiy, A. A. Kotlyarevskiy, I. A. Fuzaylov et al.), and also according to data of new bore-holes, is comprised at present new diagram.

The paleozoic formation/education, which emerge on surface in Chatkalo-Kuraminskikh mountains, was outlined under the mezokaynozoyskim jacket of Tashkentskogo region. Geological-geophysical materials confirm the validity of communication/connection of the "buried" paleozoic funamdneta with the paleozoic outcrops of Chatkalo-Kuraminskikh mountains.

This territory into rifeye composed part of the Russian-Chinese platform (A. V. Korolev, Kh. M. Abdullaev, O. M. Borisov), which for time of Caledonian cycle of motion experienced makings more active and fragmentation (stage of transfer table). In the beginning of Hercynian cycle, here will arise median mass, surrounded by the paleozoic geosyncline: the Urals - into west, B. Karata, Naryna, Chatkala - on north and Kakshaala and south Tyan'-Shayaya - in south. Toward the end of the Paleozoic period the place of median mass engaged large megasinklinoriy, on the spot of geosyncline, appeared meganticlinoria.

In order to explain the composition of the rock/species, which

ccmpose paleozcic basement, is bygone is petrographical studied ccre cf six blowholes (Yangiyul', tc-z Sverdlcv, the experimental station im. shredder, Aktepa, the region cf vegetable basis, Keles) is drawn material cn 16 blowhcles cf Syrdar'inskcy deprssii.

Fcr the connecting/fitting of the ccre cf blowholes with the discovered rock/species cf the region cf talc, are studied the sedimentary-vclcanogenic thicknesses cf carcre - the lower Permian period cf the south-west spurs of Chatkal'skcgc spine/ridge, to the Karzhantau also of the region of the villages. cf Narimanovki, then lcwer Carboniferous limestcne of Kazykurta and small paleozoic projection cf the Bogonali-Mansurata where there are also terrigencus rock/species of tyul'kubashskcy suite and granites.

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All this made it possible tc presert the ccmmcn picture of the propagation of those or other ccmplexes cf rock/species on an entire area (Fig. 122). Further tales are used geophysical methods.

Geophysical methods.

The physical properties of the rocks cf Pritashkentskogo regicn are studied by the main chracm throughout specimen/samples made of Chatkalc-Kuraminskikh mountains (V. V> Kuznetscv, F. G. Beshetov, P. G. Akhmatov, I. M. Mel'kancvitskiy, V. I. Ecykc, n. Ya. of Kunin, A.

G. Khvalovskiy, V. Ya. of Lapidus, etc.). Were investigated predominantly magnetic and density properties, in less measure - electrical conductivity, radioactivity, the speed of the passage of ultrasound. As a result of the analysis of the magnetic properties of rock/species, are made the following conclusions.

All the sedimentary rocks of mezokaynozoyskogo age are virtually nonmagnetic or weakly magnetic. Their magnetic susceptibility lie/rests at the limits of ones and first dozen (10^{-6}).

The sedimentary-metamorphic rock/species of paleozoic complex (limestone, marble, schists, sandstones, conglomerates, etc.) are also nonmagnetic or weakly magnetic. The suppressing the majority of them possesses magnetic susceptibility in the limits of first dozen ($x10^{-6}$) CGS, average value composes 20.10^{-6} CGS. Even smaller values characterize the value of remanence. Exception/eliminations compose the metamorphic formation/education, which are located in contact with igneous rocks (skarnirovaniye, orogovikovaniye, etc), or enriched by ferromagnetic minerals as a result of the processes, connected with magmatic and postmagmatic activity. The magnetic susceptibility of these rock/species can reach many thousand $x10^{-6}$ of CGS and cause very intense magnetic anomalies.

The magnetic properties of igneous rocks change over wide limits, whereupon is noted an increase in the intensity of magnetization with an increase in the alkalinity. Are most magnetic the basic and

ultrabasic rocks; least - granites and alaskaites. Sufficiently high intensity of magnetization they possess, as a rule, granodiorite, diorite, siyenitodiority (700-2000 Oct. 10^{-6} CGS). Among volcanogenic formation/education also is observed certain increase in the intensity of magnetization with an increase in the alkalinity: acid differences in the paktichesk are nonmagnetic, more basic (diabases, spilites, basalts, etc.) can be related to magnetic (to 1000 Oct. 10^{-6} CGS). Among the basic volcanogenic rock/species along with magnetic differences are encountered also normagnetic.

Density of rock/species. The geological cut/section of Pritashkentskogo region is characterized by the density heterogeneity: are here noted the boundaries, which cause the different in size/dimensions and intensity gravity anomalies:

1) the surface of paleozoic basement;

2) the litho-petrographical heterogeneities of premesozoic formation/education;

3) litho-stratigraphic boundaries in the deposits of mezokaynozoya.

Sharpest as density boundary serves the surface of the paleozoic basement: surplus density on boundary Paleozoic period - Mesozoic amounts on the average to 0.4 g/cm^3.

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Not the less important anomaliyeobrazuyushchiy factor they are the heterogeneity of the litho-petrographical composition: the fluctuations of the density of different premesozoic rock/species reach $_{n}0.3$ g/cm^3. Densest they are: from those which were erupted - alkaline, basic and ultrabasic rocks; from sedimentary-metamorphic - carbonate and mineralized formation/education, and also the intensely metamorphized schists of Silurian-Devon. A deficiency/lack in the density (usually within limits 0.1 g/cm^3) possess igneous rocks of the acid series: granites, alaskaites, Karamazarskogo type grandiorite, and also youngest (P_1) vulcanites; among sedimentary-metamorphic and pyroclastic formation/education an insignificant deficiency/lack in the density is noted at the rock/species widespread volcanogenic formation of lower and average carbon.

In the examination of the density properties of the rock/species of mezokaynozoya, attention is drawn to the increased value of the density of chevertichnykh conglomerates (2.50-2.55 g/cm^3), which at considerable power/thickness exerts a substartial influence also on the average density of entire sedimentary complex. The weighted mean plotnost' of mezokaynozoyskikh deposits without conglomerates is 2.22 g/cm^3, and with conglomerates is 2.30 g/cm^3. By the minimum values of this parameter are characterized the neogene and quaternary (without conglomerates) deposits and terrigenous settlings of Paleogen (2.0-2.1

g/cm³). Anomalously high density possesses the carbonate formation/education of Paleogen (2.49 g/cm³). The average density of Cretaceous deposits is 2.36 g/cm³.

The density of sedimentary formation/education depends substantially on the depth of their occurrence. So, density at depth 3000 m can reach 0.4 g/cm³ (Kurin, 1965).

According to elastic properties the rocks of region are divided by two large groups: paleozoic, that possesses the high values of velocities, and mezokaynozoyskuyu, kharakterizyushchuyusya by the lowered/reduced velocities. the denudation-tectonic surface of basement serves as the refracting boundary with the values of boundary velocity, which vary within limits of 4300-6200, m/s.

For the geological interpretation of their boundary velocities they compared with the znacheiyami of the velocities in the paleozoic rock/species, revealed by blowholes and outcropping on topographic surface in the region of seismic routes.

Is noted determined communication/connection of mezhd by litholgic composition and the elastic properties of rock/species. By the smallest velocities of longitudinal waves they are characterized sand-schist formation/education (4000-5300 m/s) and the rock/species of the zones of tectonic narusheiy (3500-4500 m/s). The maximum values of boundary velocities (600 m/s and more) are inherent in

carbonate deposits and igneous rocks of a basic series. Entire remaining complex, presented by the predominantly magmatic rock of different composition and by metamorphic formation/education, is characterized by the intermediate values of velocities from 5000 to 6000 m, whereupon for the granitoids of acid composition velocities gravitate to lower limit, rarely exceeding 5600 m/s. At the same time is noted the mutual overlap of the intervals of the velocities in different lithologic formation/education, that it is necessary to consider with the charting/mapping of paleozoic basis/base.

In the consistent examination of boundary velocities with magnetic and gravity anomalies, it is revealed, that between them there is no full/total/complete sotvetstviya. One should assume that the gravity anomalies reflect the volume effect of the gravitational and magnetically active masses of those being arrange/located in with basic lower than the edge of paleozoic basement.

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Fig. 122. Diagram of structure and compcsition cf the paleozoic

basement of Pritashkentskogo region by data of geological photographing, boring the geophysicists. Karzhartau-Kuraminskiye mountains. the structural-formational complexes: 1 - flishoidnyy (o - S_1); 2 - molasse-vlirovyy (S_2); 3 - quartz-prophyric (D_1); 4 - terrigenous-calciferous-dolomite ($D_{2\ 3}$); 5 - andezito-porphyritic ; 6 - volcanogenic-sedimentary ; 7 - andezito-dacito-porphyritic ($C_{2\ 3}$); 8 - molassoidio-quartz-porphyritic (P_1); 9 - molassovy (P_1); 10 - molasse-quartz-porphyritic ($P_2 - T_1$). Subvolcanic complexes: 11 - quartz-syenite-porphyritic (D_1); 12 - granodiorite-porphyritic ($C_{1\ 2}$); 13 - grandiorite-granite-porphyritic ($C_{2\ 3}$); 14 - quartz-prophyric (P_1). Intrusive complexes: 15. gabbro-sienito-grandioritovyy ; 16 - diorito-granitovyy (C_3); 17 - granodiorito-granite-porfirito-porphyritic (P_1); 18 - gabbro-dioritic. Bury fundamet. the structural-formational complexes: 19. sand-schist (O - S). 20. the sections of the predominance of the outcrops of quartz-prophyric rock/species (D_1); 21 - the area of the development of the volcanogenic rock/species of the average composition ($C_{1\ 2}$); 22 - the area of the development of the sedimentary-volcanogenic rock/species of the average and acid composition ($C_{2\ 3}$); 23 - the sections of the development of the intrusions of the basic and ultrabasic composition (C); 24 - sandstones, siltstone and schists of the tyul'kubashskoy suite of upper Devon; 25 - gypsums, the dolomites, izvestryakovistye dolomites, the limestone of the famenskogo tier of upper Devon; 26 - the sections of the predominance of the carbonate otlozheniy of lower carbon; 27 - the area of the development of the sedimentary-volcanogenic

rock/species of the average and upper carbon; 28. the sections of the predominance of the terrigenous calcifercus-dolomite formations of average and upper Devon; 29 - the area of the development of the terrigenocarbonate rock/species of the average carbon; 30 - the sections of the development of the undifferentiated dolomite and calciferous rock/species of average and upper Devon and lower carbon; 31 - the area of the development of the undifferentiated terrigenous carbonate and vulkangennykh rock/species of the average carbon. Fractures. 32. reveal/detect/exposeed according to data of gravimetry and magnetometry; 33 - those assumed to be; 34 - the demarcating structural tiers.

However, within the limits of large block/module/units with calm type, foul language magnetic anomalies is observed the alternation of the close values of boundary velocities. Therefore it is possible to assume that the block/module/units are accumulated by the group of the alternating rock/species, possibly, close in age and, apparently, sostvlyayushchikh structural sublevel (tier).

The magnetic field of zone as a whole is characterized by the combination different in pleshchaddi, size/dimensions, form, sign and to intensivnsti the anomalies, which create mosaic picture. However, within this alternating field sufficiently distinctly planned the regularly arranged/located groups of the anomalies which form in Ferganskoy depression and Kuraminskikh mountains the sublatitudinal bands, but in Pritashkentskoy depression - the band of northwestern strike/course.

With the interpretation of results of all geophysical investigations and their connecting/fitting with the results of geological-surveying and drilling operations are acquired data, necessary for research on structure and composition of paleozoic basement, depth of its occurrence, isolation and tracing of fractures etc. The complex of geophysical data was interpreted as follows.

In the case of the agreement of positive magnetic and gravity anomalies, it was assumed that this combination is caused by the

presence of igneous rocks of a basic and ultrabasic series. For them are characteristic the high values of boundary velocities.

Intense isometric magnetic maximums against the background of the calm or slightly increased gravitational field were connected with the intrusions of granodiorite.

During the agreement of positive magnetic and otritsate'nykh gravity aromalies ancmaliyechrazuyushchiye bodies of interpretirovali'kak the acid granitoids, not revealed by erosion and that is why those enriched in near-contact and apical parts by ferromagntnymi minerals.

The agreement of negative magnetic and gravity anomalies was caused by igneous rocks of an acid series (by granites, alaskaites, by great thicknesses of volcanogenic formation/education).

The agreement of the calm lowered/reduced magnetic field with gravitatsonnym maximum with the high znacheiyakh of boundary velocities made it possible to separate/liberate carbonate formation/education. The analogous relationship of fields with low velocities, and frequently also with somewhat alternating magnetic field, gave grounds to separate/liberate the sections of the development of the most ancient deposits of Silurian and Devon.

The volcanogenic rock/species of the average and basic

composition were separate/liberated on the basis of characteristic slightly increased and nezakcromrno tc the excited magnetic field. In this field Ag, as a rule, had calm character, and boundary skrosti charged within considerable limits.

The local isometric and strongly elongated positive magnetic anomalies in several hundreds of gammas characterize great (to 2 km and more) thicknesses of conglomerates, is sandstone and the volcanogenic rock/species of the average and acid composition. Of arcmalies with slightly positive values ΔT - the region of the propagation Lower Paleozoic is sandstone and schists, and also nizhnedevonskikh quartz porphyries with the possible presence of the islets of carbonate rocks of Devon.

Large isometric positive magnetic anomalies in several hundreds of gammas were considered as caused by the masses of granodiorite and syenite-was dioritic.

TAB complex alternating magnetic field was interpreted as field of develcping of sedimentary-volcanogenic formation/education and intrusive masses.

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Areas the calm negative and polozhitel'nymi arcmalies of small intensity were considered the place of the develcpment of sand-

carbonate thicknesses the possible participation of volcanogenic rock/species.

The disjunctive disturbances, reveal/detect/exposeed according to the results of each of the geophysical methods, were compared between themselves, with geological map/chart and the results of boring. some disturbances are isolated completely confidently, others - are less confidently (the first are separate/liberated by dvumyageofizicheskimi methods, or one of the methods of geological studies; are less confidently are isolated disturbances according to data only of one any method).

Besides the examined factors, with the qualitative interpretation were considered the information about form, size/dimensions, the depth of occurrence, the results of the determination of effective intensity of magnetization and density, and also of the intensity of geophysical anomalies and general geological situation.

Geological methods. .

For isolation and classification of structural-facies ones of the earth's crust it is possible to accept the "principle of the mobility of the individual sections of the earth's crust". proposed by Kh. M. Abdullaev (1959-1960). At its principle lie/rests the assumption about the intimate interconditionality of the processes of tectogenesis, magmatogenesa and rudogeneza and their consistent

razivtii in vremenii space. In this case, it is possible to solve two problems: postroyeniyeskhem geological division into districts and the composition of tectonic map/charts. By this are predetermined two systematic approaches to the analysis of the starting materials: structural-formational (more precise than geotectonic-foraqionnol) and tektono-stratigraphic.

At the principle of geotectonic-formational procedure, lie/rests the concept about about the fact that the structural-formational plan/layout regularly changed both in the course of time and in space. In time these changes occurred on the logical-istoricskix borders of the megahertzes of cycles, stages, stages etc., and in space - from one structure to another corresponding scale. Simultaneously changed the qualitative and quantitative characteristic of plicated and disruptive structures (form, the degree of strain etc.) and of geologicheskikh formation/education (form, composition, the completeness of cut/section, power/thickness etc.).

With this approach for each interval of time, clearly are separate/liberated two type of the sections: with the preferred deflection and relatively elevated. The first kharakterizuyutsya by the increased power/thickness of deposits, by the full/total/complete type of cut/section by a small degree or the full/total/complete absence of scouring/eroding on boundary with the superincumbent deposits of another structural subdivision, the synclinal form of the composition of precipitation, etc. The second are characterized by

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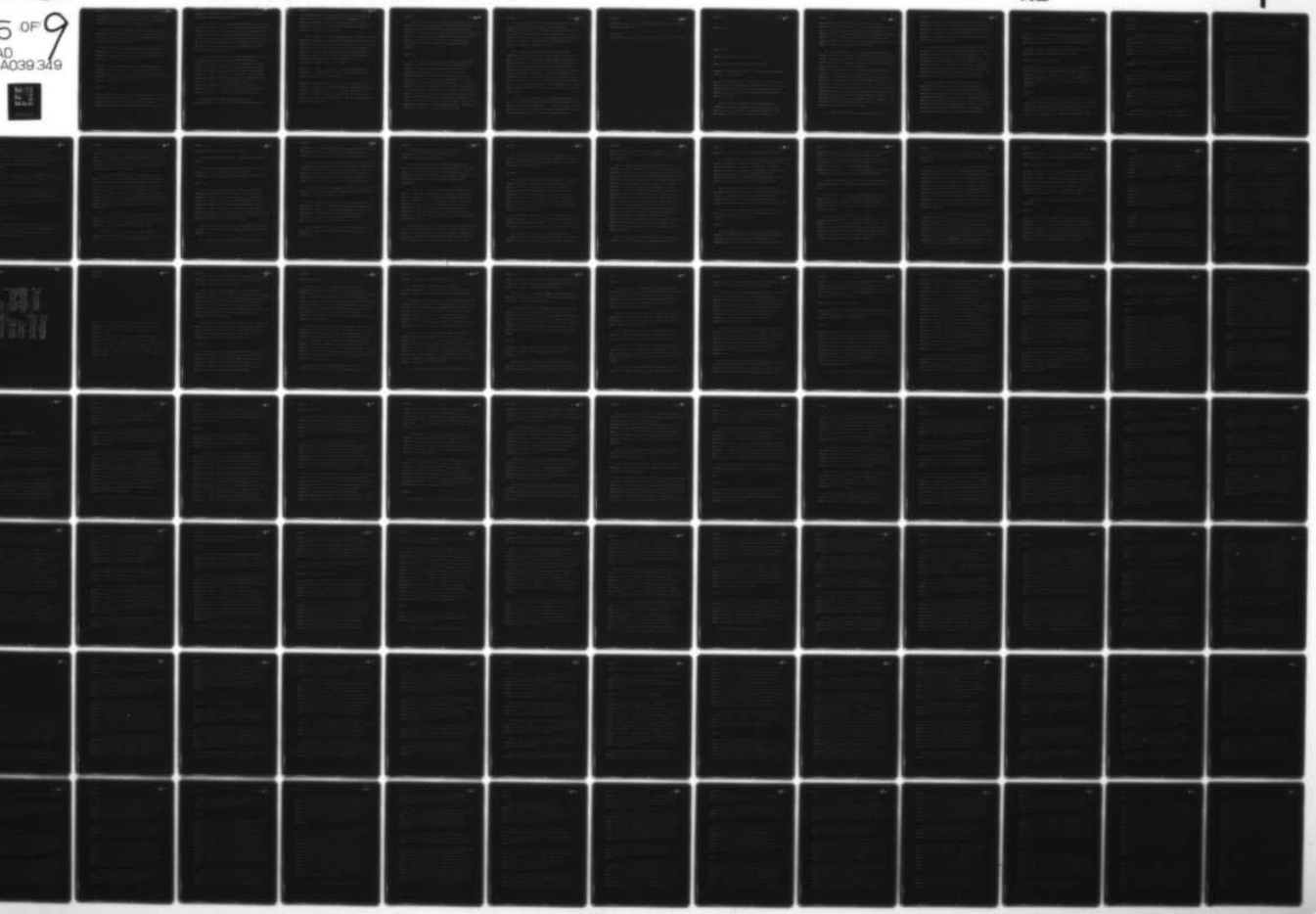

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the abbreviated cut/sections of deposits with the sign/criteria of deep scouring/eroding, the abbreviated thicknesses, more variable composition, the anticlinal form of structure, etc.

Geotectonic-formational method reveals the history of the development of the individual sections of the earth's crust, it makes it possible to isolate the genetic types of structures according to the character of their development.

With the tektono-stratigraficheskommetode of time unit - the megahertz, stage, cycle, stage, etc - will be expressed by the structural-real associations geological formed; - megetazhom, by floor/stage, tier [1], by substage, etc.

FOOTNOTE [1]. Use the submerged case of term "tier" it cannot be recognized successful, since this term has a poshno rating value in stratigraphy. We leave it here, in order not to change the logic constructed circuit of presentation, proposed by the authors of this chapter. - editor's note. ENDFOOTNOTE.

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In space (by way of the umo'shoniya of scale) this also will be the concrete/specific/actual structures: platform and plicated belt/zone, plicated zone and poluplatforma, meganticlinorium also of megasinklinoriy, anticlinorium and synclinorium etc. qualitative-

quantitative characteristic is reflect/represented by geological complexes (sedimentary magmatic, cre).

Thus, unlike the first method, tektonc-sratigraficheskiy method reflects the conditions of the determined torque/moment, which formed toward the end of the determined period of tectonic rzvitiya (for example in our case, Hercynian), but not dlite'nyy time interval. If in the first case materials are the paleogeographic diagrams, then in the second - paleogeologicheskiye. it is clear that the precise and more ideal the geological map/chart, the effective the tectonic map/chart, created on its principle.

By the Sterezhnevoy part of the tektonc-stratigraphic method is the pravil'noyeopredeleniye of age boundaries megetazhey, floor/stages, tiers, etc. These structural subdivisions, presented, as the final result, by rocks, personify in themselves essential features of tectonic mode/conditions and are the really existing existing geologicheskimi bodies. In other words, each structural subdivision unites the complex structural, the cell/elements, which arose under one and the same tectonic conditions and fixed in the rocks, which subjected to tectonic effects. The special feature/peculiarities of tectonic mode/conditions and its change are reflect/represented in the real composition of rock/species.

Consequently, structural subdivisions cre should separate/liberate on the basis of the natural history association of

the textural-real formation/education, united by their development under one and the same tectonic conditions. Knowledge of the obshcheregional'nykh special feature/peculiarities of tectonic motions, in turn, helps to more precisely formulate the space-time boundaries of structural subdivisions.

This corrective special feature/peculiarity is rhythmics tectonic dvizheniy,kotoraya it is expressed in the fact that for the determined interval of time (megahertz, cycle, stage, stage, etc) is accomplished one rhythm of the motions: depression - lift. In structural-real relation this is expressed as follows: the sedimentary deposits compose ritmomegatolshchu, ritmomezonadtolshchu, ritmotolshchu, ritmosvitu [1] and, etc, each of which includes two series of rock/species - transgressive and regressive.

FOOTNOTE [1]. It seems to us that the geological terminology and takslishkom is complicated and tangled in order to introduce new terms. - editor's note. ENDFOOTNOTE.

Magmatic formation/education also composes the progressive and regressive series of the rock/species where to posledovatel'not' the emergence of rock/species it goes for the first series of basic to acid, for the second - from the acid to basic. The corresponding series form the ore formation/education: first chalcophilic displace oxide, then vice versa.

Consequently, the volume of structural subdivisions is monitored by the volume of the corresponding to scale rhythm of the sedimentary, magmatic and ore formation/education, constituting determinate structure. The intensity of tectonic motions in space is variable and causes the types of structural subdivisions, whereupon usually these changes occur abruptly on the boundary of the heterogeneous block/module/units where usually the raspolagaetsyasistema of fractures.

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During intense tectonic motions appear plicated structures, in connection with which horizontal boundaries usually rosary are expressed by azimuth and angular unconformities and large stratigraphic interruptions. During weak tectonic motions kondisementatsionnye structures prevail above phase, and then horizontal boundaries are ill-defined, diffuse and it is created the impression of the concordant (parallel, according to A. K. Basharin) occurrence of structural subdivisions. The latter fact gives occasion to some researchers to consider these ill-defined relationships as intrastructure, but not as interstructure. In this case the volume of structural subdivisions (besides the criterion for rhythmics) can be in rough form determined by time of their formation: 500-600 million summers for a megetazha, 180-200 million summers for a floor/stage, 35-40 million summers for a tier, etc (Khain, 1964).

In the geological practice of boundary megetazhey, and especially floor/stages (Caledonian, Hercynian and Alpine), they are separate/liberated more or less clearly. More badly is matter with the breakdown of floor/stages to tiers. The procedure for the isolation of structural tiers for the paleozoic formation/education of Tien Shan is bygone is develoced by M. A. Akhmedzhanov and O. M. Borisova in 1962 and is published in 1964.

By structural tier they understand the natural history associations of geological complexes (sedimentary, magmatic, ore), which are formed in the determined stage (initial, early, average, late, final) of the tectonic cycle, during which is accomplished one rhythm of tectonic motions (depression - lift) are created the determined structural forms, bounded above ard by the from below clear or concealed/latent unconformities. Part of the structural tier, qualitative-quantitative characteristic of which substantially does not change on the defined area, is considered as type of structural tier. Each type usually corresponds to the structural-facies subzone, limited by fault system and which possesses the unity of structural plan/layout.

Correspondingly it is possible to formulate the concepts also about other structural subdivisions, by taking into account in this case the scale of subdivisiors. LN3 Within the limits of Central Asia we is isolated two structural megetazha: Riphean and Paleozoic period-mezokainozoiskii, each of which it contains on three

struktuRNykh floor/stages, and each floor/stage, in turn, it contains
cn five structural tiers.

End section.

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Structural MEGAZTAJI, floor/stages and tiers.

Riphear (Upper Proterozoic) structural megaetazh [1].

FOOTNOTE [1]. To basin is applied in the same sense term "complex". - editor's note. ENDFOOTNOTE.

Riphear megaetazh includes the deposits of the average and upper rifeya and venda and outcrops on insignificant areas in the northern Pamirs, south-west Gissare, to Mogoltau, Kassane, Pskemskom and Sandalashskom spine/ridges, but predominantly within the limits of northern Tien Shan.

Riphean megaetazh is complex by three floor/stages: grenvil'skim, deliyskim and Baikal, but the only latter of them outcrops into the predelakh of Chatkalo-Kuraminskikh mountains. The first (lower) half of Baikal floor/stage is accumulated by

verkhnerifevskimi deposits, the second - vendskimi. In the composition of Baikal flcor/stage, it is distinguished five structural tiers: I - sarydzhoyskiy, II - terekskiy, III - semizsiyskiy, IV - nizhnevendskiy, V - verkhnevendskiy. Among the rock/species of Baikal flocr/stage, are encountered the limestone and marble, micaceous schists, argillites and gneisses, conglomerates, sandstones and also diabasic and andesite porphyrites and their tufas.

The total power/thickness of the deposits of Baikal flcor/stage varies within limits 3000-4500 m. Among dislocations are most common intermittent type brakhiskladki. As a whole, tectonic mode/conditions and the character of steeling-accumulation indicate the platform type of the development of this section of crust in verkhnerifeysko-vendskoye time. The insignificant power/thickness of deposits, the continuity of steeling-accumulation a the period of Baikal cycle, predominance in the composition quartz are sandstone, low speed the accumulations of precipitation (0.003 cm/yr) testify in favor of presence here in late rifeye and the vende of platform. The Mclasscidnyy character of the deposits of a venda (of type of foremost downwarp/troughs), presence the brakhiskladok of the intermittent type and intrusive bodies of plagiogranitnogc composition indicate the fact that here was arrange/located the boundary part of the platform, which subjected to the superimposed making more active from the side of the Riphean geosniklinali of northern Tien Shan.

V. G. Korolev considers the ssverney boundary of Precambrian

platform the "most important structural line" V. A. nikolaeva. Hcwever, as a result of the great similarity of the cut/sections of the upper rifeya and venda of Karatau-Kuraminskikh mountains it is possible to move aside the bcundary of platfcrm up to the Terskcgo Alatau where was arrange/lccated Riphean greenstcne geosyncline of ncrth-ncrth-western strike/ccurse.

In connection with the relatively small size/dimensions of the cutcrops of the rock/species cf Riphear megaetazha, and alsc the exceptiocnal colorfulness of the geclogical strcniya of the territory in question tc establish/install the marifestaticn of these rcck/species cn the map/charts cf magretic, and by the fact more gravity anomalies is impcssible. On the basis cf the physical properties of the rock/species enumerated abcve, we assume that the Riphean formation/education must be reflected in surface by calm magnetic and by somewhat increased gravitaticnal by fields.

Within the limits of the buried palcozcic basement of Pritashkeitskcgo regicn, accrding tc palecgeolcgicheskim tc the reccnstructions of A. A. Aripova, M. A. Akhmedzhancva and O. M. Bcrisov, Riphean deposits are widely develcped and they compose the sedimentary-metamorphic basis/base which in contemporary cut/section must be arrange/located cn depth 6-8 km cf surface. The depcsits of venda here, apparently, are absent, since at that time this section was low land for which is characteristic the predominance of the processes of denudation abcve the processes cf accumulation.

Paleozcic period-mezckaynozcizskiy structural megaetazh [2].

FOOTNOTE [2]. Deserves attention the thought to divide this megaetazh (complex) into two independent - paleozcic (Caledonian and Hercynian) and mezckaynozoyskiy (Alpine). - editor's note. ENDFOOTNOTE.

Megaetazh clearly is divided into three structural stages - Caledonian ($Cm-D_1\ell_1$), Hercynian ($D_2\ell_2-T_1$) and Alpine (T_2-Ng).

Caledonian structural floor/stage.

In Karzhantau-Kuraminskikh mountains the floor/stage protrudes on insignificant sections (Belyavuty, Shavas, Akchay, Kalkanata, Sukcksay), occupying large areas only in Chatkale (Pskemskiy and Sandalashskiy spine/ridges). For a Caledonian floor/stage it is possible to outline two type of the cut/sections: Chatkal'skiy and Kuraminskiy.

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Unlike the Chatkal'skogo, the Kuraminskiy type of cut/section is characterized by intermittent steeling-accumulation how is caused the lenticular structure of thicknesses, being even more amplified by the local development of volcanic activity. This testifies to the multiplicity of uplift/rises and divided them downwarp/troughs. Here

predominate siltstone, schists, the volcanogenic rock/species of the average and islogo composition, in the less measure of izvestiyaki.

The boundary of two types of cut/sections is planned on the external edge of the development of nizhnedevonsikh volcanogenic rock/species (from the east to west): from verkhov'yev r of Chanach south in lower reaches of the river r of Mazarbash, then in lower reaches of the river r of Ters to its northern inflows and using the Kumbel"-Ugamskoy system of fractures.

In Caledonian structural floor/stage are separate/liberated the following five of structural tiers.

I tier (nizhnekembriyskiy). Within the limits of Chatkal'skoy subzone, are three types of the cut/sections: silicide-schist calciferous and sand-schist. In Karzhantau-Kuraminskikh mountains it does not outcrop.

II tier (Middle Cambrian-nijneordovkskiy) with the visible azimuth and stratigraphic agreement overlays the deposits of lower Cambrian. Presence in the basal conglomerates slabockatannoy pebbles of siliceous rocks of lower Cambrian gives grounds to speak about the presence of the "concealed/latent" interruption.

Are planned two type of the cut/sections: the first - terrigenocarbonate is developed in the limits of Maydantal'skogo,

Pskemskogo and Sandalashskogo spine/ridges and has a power/thickness 250-300 m. The second - carbonate-terrigenous-volcanogenic outcrops within the limits of Chatkal'skogo spine/ridge and in basin r of Kassan. The power/thickness of deposits varies from 500 to 1500 m.

In Karzhantau-Kuraminskikh mountains the deposits of this tier do not outcrop, but their presence completely possibly.

III tier (srednеordovikskiy) includes deposits landeylo, lower and average karadoka. The indicated age is establish/installed on I. D. Dorofkin's collections (1959), and late F N. Abdullaeva (1965) from the deposits of the beshtorskoy suite of diverse fauna (trilobite, Gastropods, pearlweed, graptolity) and to the collections of A. F. Stepanenko's graptolitov from chanachskoy and karatauskoy suites. The deposits of tier are separate/liberated by the surfaces of unconformity from the underlying and superincumbent (ayutorskaya suite) formation/education. By V. Chatkal'skoy to subzone the tier is characterized by two types of the cut/section: schist-sandstone (220-460 m) and sand-schist-volcanogenic (600-1500 m). In Karzhantau-Kuraminskikh mountains this tier, includes thickness (to 600 m) the flishoidno of the alternating schists, is sandstone and siltstone with the fauna of the average Ordovician (to Mogoltau). In all probability, this tier has foul language propagation, including in Pritashkentskom region.

IV tier (verkhneordoviksko-nizhnesiluriyskiy) includes the

deposits of the upper Ordovician and lower Silurian's landoveri. In basin r of Sumsar, are deposits of bottoms of the venloka by which is married this tier.

As in the preceding case here are separate/liberated two type of the cut/sections: sand-siltstone and sand-schist-vulkaogenny1. The first type of cut/section outcrops on the area of Pskemskogo and Sandalashskogo spine/ridges.

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The second - covers the south-west extremity of Chatkal'skogo spine/ridge and the basins of the rivers of Kassan and Sumsar.

The deposits of this tier from the region of almalyk, probably, stretch themselves under the jacket of mezokaynozoyskikh deposits to the region of Yangiyulya.

V tier (verkhnesiluriysko-nizhnedevonskoy) is represented only by sand-volcanogenic type of cut/sections. Depcsits of this type compose the wide field between the rivers of Kassan and Sumsar which stretches itself from west to the east in Chatkal'skikh mountains. In Karzhantau-Kuraminskikh mountains the tier was formed predominantly under conditions of subcontinental mode/conditions. It is represented by the nizhnemolassovym complex whose composition strongly changes both on the horizontal and on vertical line. The deposits of this

tier in enclosed territories according to geophysical data are outlined in the lower part of the Pritashkentskogo region (Kaynar-Yangiyul'skiy, Kamkurskiy regions, etc.). They are frequently limited by the zones of fracture dislocations that it gives to separate/individual block/module/units the most diverse configurations.

It is possible to assume that in the predelakh of Tashkent region is widely developed formation/education of V structural tier with the predominance of sand-volcanogenic rock/species.

Thus, Caledonian structural floor/stage within the limits of the territory in question is represented by predominantly terrigenous formation/education with the insignificant participation of the volcanogenic rock/species of the average and acid composition. Their total power/thickness does not exceed 5 km.

Hercynian structural floor/stage.

It involves geological formation/education from average Devon to lower trias inclusively. Are planned two type of the cut/sections: karbonatnogranitnyy (Chatkal'skiy) and carbonate-volcanogenic-grandioritovyy (Kuraminskiy).

The almost full/total/complete absence of volcanogenic deposits, the sharp predominance of carbonate rocks of transgressive sorni (D_2-C_1), the continuity of sedimentary formation/education, a small quantity of intrusions with the sharp prevalence large above fine and a predominantly granite composition these are the basic features of the Chatkal'skogo type of cut/section.

The Kuraminskiy type of cut/section is characterized by the predominance of the volcanogenic rock/species above sedimentary, by the supremacy the average in composition magmatic rock above acid and, especially above basic, by the wide development of different in age and morphology intrusive bodies with the predominance of the rock/species of hypabyssal facies. The presence both transgressive and regressive the series of sedimentary and sedimentary-volcanogenic formation/education and the multiplicity of fine and large angular and azimuth unconformities also differs this type of cut/section from the Chatkal'skogo.

The boundary between these types of cut/sections passes along fault system, named as M. A. Akhmedzhanov and O. M. Borisovs "boundary Chatkal'skim fracture", but on considerable part it coincides with the boundary of A. S. Adelung's Chatkal'skoy subzone (1964).

In the limits of the Pritashkentskogo buried basement, is developed the Kuraminskiy type of cut/section, which differs in terms of the fact that the role of volcanogenic and magmatic

formation/education in its structure decreases.

Hercynian structural floor/stage it involves five structural tiers.

I - Middle Devonian-rijneturneiskii with two types of the cut/sections: sandstone-carbonate (calciferous) and conglomerate-sandstone-carbonate (anhydride-dolomito-calciferous).

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The first covers the area of Maydantal'skogo, Pskemskogo, Sandalashskogo spine/ridges and verkhov'yev r of Chatkal and is abbreviated from below (there are no deposits of average Devon). Deposits with sharp angular and azimuth unconformity will lie on the different horizon/levels of kembro-Ordovician formation/education. Cut/section begins with red-colored conglomerates, sandstones by siltstone, with quartz-like sandstones of Frasnian tier (450-2200 m), with the displacing raznoslcistymi limestone (3000-4000 m), and also famenskogo tier and nizhnegurneyskogo substage.

The second cut/section is common in Chatkal'skom spine/ridge, in the basin of the rivers of Kassan, Sumsar, Sarydzhak and mountains to Karzhantau.

For a cut/section are characteristic facies variability in

strike/course and precipitation of odel'nykh (usually verkhnefranskikh and nizhneturneyskikh) horizon/levels, scouring/erodings, the enrichment of carbonate rocks by terrigenous impurity/admixtures.

In direction from the east to west, a quantity of preserved from erosion karbonagnykh thicknesses always increases and, apparently, in Pritashkentskom region they compose splcshchnoye field. However, their area of outcrops to the "surface" of the buried basement is insignificant and is planned by us in the form of not wide band from Sukok-Parkentskogo calciferous mass to the region of Boganali.

To north from Tashkent SKV [СКВ - blast hole] e-t (shredder) in interval of 1491-1506 are travelled pink-gray fine-grained limestone, probably, of sredneverkhnedevonskogo age.

In the region of Boganali, outcrop the Upper Devonian and lower Carboniferous deposits, presented by below milk-white gypsum and the sandstones of brownish grey color, apparently, tyul'kubaskoy suites. Above will lie the dolomitized limestone, probably, of tournvizeiskogo age, srednеplitchatye, greyish-brownish color, fine-grained, with the lenses of silitsitov.

II tier (Lower Carboniferous) covers rock/species from the upper tour of lower carbonate to the nizhnebashkirskogo substage of carbon inclusively.

Are separate/liberated two type of the cut/section: carbonate-sandstone-grandodiorite-adamellitovyl and carbonate-vulkanogennyl-grandodioritovyl.

The first type of cut/section covers entire Chatkal'skuyu subzone. It is complex by great (to 2000 m) thickness of limestone to tour-visa and is characterized by the complex of intrusive bodies (silly, the stock/rods, but prevail large masses), of gabbro, sienito-is dioritic, monzonite, but predominantly grandodiorite and zdamellitov.

The second type of cut/section ravit in lower reaches of the river r to Ugam and, being expanded to southeast, occupies the area between the Kumbel'skim the Arashanskim by fractures and region oz Kugala. Cut/section begins with lamellar chert upper to tour-visa (500-1000 m). It is possible, to this same age it is related the kyzylsayskaya suite of the volcanogenic rock/species of acid composition. Younger (namyurskimi) are the sedimentary-tufagenic complex of suite uya and the nizhnebashkirskaya datsitoandezitovaya minbulakskaya suite.

In Karzhantau-Kuraminskikh mountains the complex of the carbonate deposits of the tops of tour and to visa is developed locally, but the complex of the sedimentary-volcanogenic rock/species, which belong, apparently, to two suites - uinskoy and minbulakskoy, is developed more widely, noticeably increasing from southeast to northwest.

The formation of tier concludes with the formation of the granodiritovogo intrusive complex, which involves the fine bodies of gabbro, gabbrodioritov, sienito-is diritic and the large masses of Karamazarskogo type granodiorite.

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All around to Karzhantau and about Tashkent are fields of the increased intensity of magnetization, which makes it possible to assume to be here the development the average in composition volcanogenic rock/species, analogous to the rock/species of minbulakskoy suite. Specifically, to the south from Kazykurta, according to data of seismic survey, the value of boundary velocity varies from 5000 to 6000 m/s, and the intensity of anomaly varies within limits of +1000-+2000 of gammas. Here SKV 12 are travelled vulcanites of andesite porphyrites.

In neighborhoods of Tashkent SKV 1 - the Aktepa and SKV 1 - vegetable-growing are revealed the tufas of andesite porphyrites, in petrographical composition analogous to tufas of k. of Nevich (by O. M. Borisov in 1967 is established/installed their doakchinskiy age).

Apparently, to II to tier it is necessary to relate the isolatable according to magnetometric data intrusive bodies magnetic anomalies which are analogous to the anomalies above gabbro-diorite of

Shavasskogo mass and Karamazarskogo type granodiorite. To the south from Lengera SKV 476 and to west from Chimkent SKV 5-G are revealed the granodiorite.

III tier is verxnekarbonovyl. Its upper boundary is the psevdoshvagerinovyy horizon/level of the tops of the upper carbon, everywhere with sharp azimuth and angular nesoglsiyem overlapping the more ancient formation/education. Sedimentary-volcanogenic deposits and subvolcanic analogs compose thickness by thickness from 1 to 3 km (akchinskaya, nadakskaya and cyasayskaya suite) and are widely developed to the south Ugam-Kumbel'skogo fracture. They are represented by tufaconglomerate, tufo-sandstones, tuffitami, tufas, thinner by the lavas of andesite porphyrites, dacitic and quartz porphyries with the layers of conglomerates, schists and limestone with the fossilized residue/remainders of the average and upper carbon. They proryvayutsya by large granitoids, thinner by the fine masses and the stock/rods quartz is dioritic and siyenitodioritov, granodiorite, adamellites, granites (balayolskiy, kyzylsayskiy, kenkol'skiy and arashanskiy types). In comparison with sedimentary-volcanogenic formation/education the intrusive rock occupy vaster area, they compose the masses and the stock/rods within the limits of Chatkal'skogo spine/ridge, in the basin of the rivers of Kassan and Sumsar.

From the east to west, is planned an increase in the terrigenous rock/species in the composition of volcanogeric thickness and an

appearance in the upper part of the tonkocklomocknykh differences.

It is possible to assume that to west from Tashkent volcanic rock in the composition of tier almost disappear, but appear the prosloi of clay shales, siltstone, argillites and limestone. A similar interstratification of rock/species is predominantly sandstone with limestone, is travelled SKV 96 and 2-P in the south of Pritashkentskogo region. SKV 4-P are revealed argillites with the layers is sandstone, which we is also related to this tier.

In region g. of Tashkent (SKV 9, Tekstil'kombinat), g. of Yangiyulya (SKV 2-T) and to-for im. Sverdlov (SKV 1) is revealed the thickness of kontlomeratov, is sandstone with the layers of tufopeschanikov, tuffitov. By petrographical composition it completely reminds the deposits of nadakskoy suite (average carbon).

SKV 10 (to-z im. Sverdlov) lower than kaolinirovannoy crust of wind erosion (inter. 2620-2648 m) is travelled the bundle being interbedded is sandstone and siltstone.

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IV tier (Lower Permian). In Karzhantau, in right bank of Argrena, to Karamazare this tier is represented by conglomerates, sandstones, tufopeschanikami, andesite porphyrites but by predominantly dacitic and liparite porphyries (shurabsayskaya and

ravashskaya suites) whose power/thickness reaches 2 km. They occupy small by area sections, also, with large angular and azimuth nesoglsiyem they overlap more ancient (up to Silurian) geological formation/education. In basin r of Kassan, unlike other sections, terrigenous deposits predominate above volcanogenic. Is characteristic the presence of the large subvulkanov one their which is arrange/located in headwaters r of Argrer (Balaytanskiy).

This tier includes the very variegated in composition complex of the rock/species, constituting the stock/rods, dike-shaped bodies and dikes.

The deposits of this tier under mezokayrozoyskim jacket are arrange/located to west from Badamsaya and Chevlisaya, where these deposits compose large outcrops. However, in other regions of Pritashkentskoy depression, the deposits of permo-trias as a whole are very problematic.

V tier (verxnepermo-Lower Triassic) involves the sedimentary-volcanogenic deposits of kyzylnurinskoy suite. These deposits compose the isolated/insulated areas and sections on right bank of Angrena, eastern than the mountain of Tashkesken, Tavakskogo plateau are accumulated by tufas, by tuffaceous lava, ignimbrite of felsite and liparite porphyries, sometimes with low-power prosoyami is sandstone and conglomerates in basis/base (400-600 m).

Tier is completed by the series of the dikes of basic (they preobldayut) - subalkaline - acid composition, the components dike belt/zones.

In each structural tier clearly are exhibited two type of the cut/section: Chatkal'skiy and Kuraminskiy, the rock/species, characteristic for the middle part of the Chatkal'skogo spine/ridge and basin of the rivers of Kassan and Sumsar, they possess some features, on the basis of which they are related to intermediate, between two these types to cut/section. However, the majority of features draws together this region with Kuraminskim, which makes it possible to consider it the boundary part of the Kuraminskoy subzone. This is confirmed by the special feature/peculiarities of the tectonic development: region experience/tested the same motions, as Kurama, while the Chatkal'skaya pozona differed in terms of more considerable in motion amplitude.

For a Hercynian structural floor/stage is noted a change in the composition of rock/species from the east to west. So, the sand-marl-carbonate thickness of average and upper Devon is replaced sclenosnoterrigennoy, volcanogenic formation/education displaces volcanogenic-sedimentary, sharply grow/rises the role of limestone (C), sedimentary-volcanogenic thickness (C_1) is replaced by rhythmic alternation is sandstone, siltstone and limestone, but molassoidno-volcanogenic formations (C_{2-3}) pass over to red-colored. The lines of the exchange of facies pass approximately from Chimkent in the

direction of Dzhizaka. In the past here some researchers carried out the Pritashkentskiy fracture, subsequently removed from map/charts.

Alpine platform structural floor/stage.

It involves geological formation/education from the average trias to the average oligocene. The deposits of structural stage protrude on the western orogakh of Chatkal'skogo and Kuraminskogo spine/ridges. On northeast they by almost continuous band clothe the zone of the subsidence of spine/ridge to Karzhantau, in south and in the south-west part of the territory are revealed at depth by boring, only on north they compose large areas, outcropping on surface.

Structural stage is characterized by the platform conditions of development.

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To its special feature/peculiarities it slduyet to relate small amplitudes of the vertical tectonic motions: the accumulation of the precipitation of predominantly epiplatformennykh facies with their subsequent transformation in thicker than the rock/species as quartz sandstones limestone, dolomites and sulfate connection/compounds: comparatively small power/thicknesses of mezozoyskikh and Paleogene deposits, and also the maldislokatsirovannost' of layers.

On the usoviyam of formation in platform deposits it is possible to isolate two type of the cut/section: full/total/complete and incomplete. The stratigraphically full/total/complete include the only cut/sections of south and south-west uzbekistan. In the remaining territory of rezrezy more or less abbreviated. Distinctive features of incomplete cut/sections is continental genesis of lower suites and maritime - upper.

In Pritashkentskom region Alpine platform structural floor/stage begins from Jurassic deposits, in the innermost parts of the downwarp/troughs - even from Triassic. After the outline of the propagation of triaso-yurskikh rock/species, on the washed away and uneven surface of paleozoic basement with the clearly expressed angular unconformity will lie the different horizon/levels of Cretaceous and even Paleogene deposits.

The sharp differences in the structure of cut/sections, caused nepreryvnopreryvistymi tectonic motions, and also changes in the lithologic special feature/peculiarities and the character of the occurrence of layers make it possible to isolate in the deposits of Alpine platform structural floor/stage five of structural tiers.

I tier (srednetriaso-lower Jurassic). To time of the completion of the formation of the rock/species of I tier, the investigated region underwent sufficient to intense tectonic breakdown with the corresponding uplift/rise, which caused the processes of denudation;

to the area of the supremacy of the processes of sedimentation tales were scattered and were the small isolated/irsulated downwarp/troughs. As a result of the subsequent intensificatior of scouring/eroding, the settlings by places, possibly, are completely destroyed. In connection with this the deposits of structural tier are extremely failed and their dating at times hinder/hampered.

The lower part of the cut/section is represented by the crust of wind erosion. Its age conditionally Triassic. The upper part of the cut/section in many places is absent, but where it has, the crust of wind erosion was preserved almost completely. It composes the small isolated/insulated sections in Azatlashe, Samsareke, Tashkent and its neighborhoods. Highest efficiencies are noted in Angrenskoy valley. The crust of wind erosion is represented, in essence, kaclinizirovannymi quartz tufas and breccia. By their places replace the ferridized argillites or the brecciated aluritized rock/species.

The deposits of the upper part of the cut/section were preserved badly/poorly, and difficult to separate/liberate them from Middle Jurassic formation/education. In Pritashkentskom region they are revealed on one-and-a-half structure and on Klewhole "shredder". According to palaeontolological data they are related to the lower--average/mean Jurassic (Fig. 123).

In Angrenskoy valley the crust of wind erosion transgressively overlaps the series of the rock/species of marshy-river facies -

slabouplotnennykh is sandstone, siltstone, the clays, which are moved with the layers of carbon. In their basis/base are separate/liberated the basal layers, which V. A. Zakharevich (1966) conditionally relates to lower Jurassic. The power/thickness of basal layers reaches 50 m.

II tier (average-Upper Jurassic). The deposits of tier are known in several point/items where they form the small isolated/insulated sections. In the valleys of rivers to Ugam, Pskem and the Karankul' their cut/section begins with quartz sandstones, schistose clays with the layers of carbon, higher than which lie/rest calcareous sandstones and arenaceous clays. Or mneniyu T. A. Sikstel' (1955), these rock/species, must be related to the average and upper Jurassic. In their basis/base will lie the boksitopodobnye rock/species, which are the crust of the wind erosion of paleozoic limestone (Belen'kiy, 1961).

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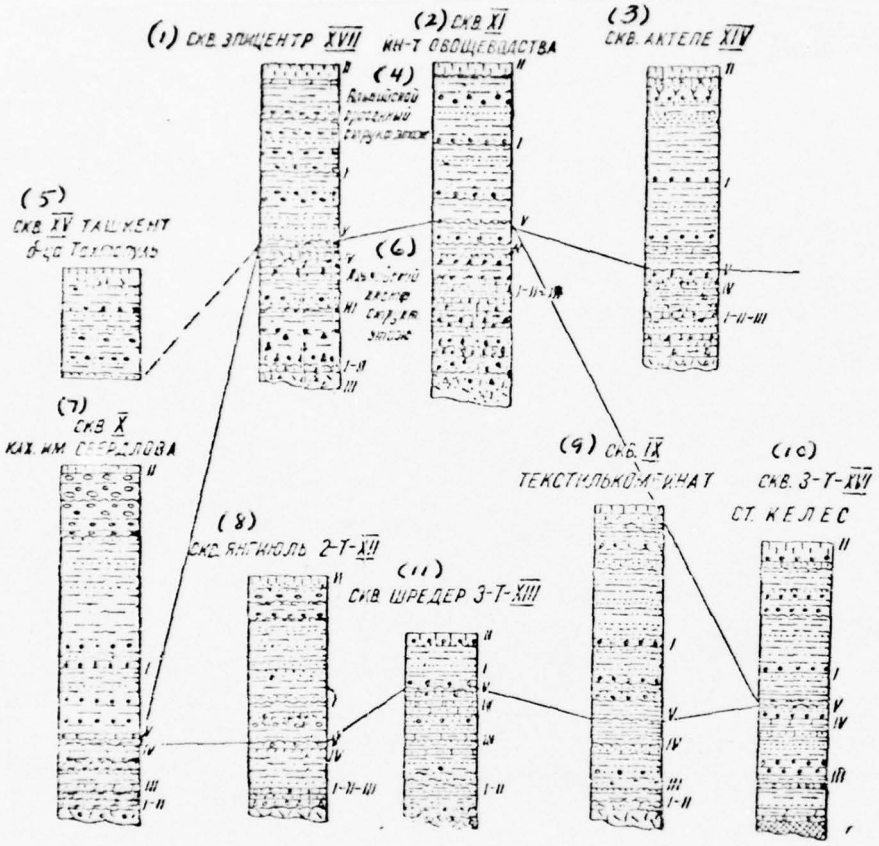

Dig 123.

Fig. 123. The diagram of the comparison of cut/sections on the blowholes of territory g. of Tashkent and its suburban zone for the correlation Alpine structural floor/stage (roman numerals are structural tiers).

Key: (1). SKV epicenter of XVII. (2). SKV XI institute of vegetable-growing. (3). SKV AKTEPE ARE XIV. (4). illegible. (5). SKV XV Tashkent b-ga of Takhtepul'. (6). illegible. (7). SKV X of KAX. to them sverdlova. (8). SKV 4NGIHI6 2-T-XII. (9). SKV IX TEKSTII'KOMBINAT. (10). SKV 3-T-XVI the stage of KELES. (11). SKV shredder 3TXIII.

The deposits of structural tier are enccuntered in other parts of the adjacent territcries cf Pritashkentskcgc region; in Lengare, in the valley cf Angrena ard in cther places.

Near Tashkent Jurassic deposits are revealed by blowhole "shredder". They consist frcm bottcm tc tcp cf breccia, is sandstone, clay shales, the siltstcne, enriched by carbcnate schists, the large layers of carbon, clays. The pcwer/thickness cf these deposits reaches 140-150 m, which confirms the pedpolczhenive of O. A. Ryzhkova, R N. Ibragimova et al. (1961) about the wide develcpment cf Jurassic formation/educaticn within the limits cf Tashkent-gclcdrcstepskc1 basin/depression.

Supposedly the Jurassic deposits irclude also the mansuratinskaya suite, which slopes lower than red-colcred Cretacecus rock/species rear Mansuratinskogo uplift/rise, and the multicclcred rock/species in Azatbashe, which in lithclcgic compesiticn are close to the carboniferous obrazovaiyam cf Lengara ard Angrera.

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III tier (Lower Cretaceous-Sencman) includes the azatbashskuyu ard charakskuyu ssvity whose deposits are ccmmcn almost everywhere, but their interrelatien with basement rccks in different sections different. By places they lie down without agreement to the rock/species of triasc-Jurassic age, and where they are absent, with even sharper angular unccnformity overlap paleczcic

formation/education.

Azatbashskaya suite is formed by predominantly coarsely fragmental red-colored deposits. The only separate/individual horizon/levels are represented by the interstratification of sandstone clays. In the region of Azatbasha and of basin r Uya coarsely fragmental material consists of slaboczhatannykh fragments of effusive rocks, in Mansuratinskoy and Bogaralinskoy structures are encountered the fragments of izvestiyakov and tufagenic is sandstone. Into west in Dzhausumkumskoy structure, is observed the predominance is sandstone and clays with the content of the brecciated rock/species, appear basal conglomerates.

In Tashkent and its neighborhoods, azatbashskaya suite is revealed by several deep blowholes. The cores, raised from blowhole, they showed that the lower part of the suite was accumulated by the rock/species of prolyuvial'nykh facies with the fragments of breccia and the badly/poorly rounded pebbles of the rock/species of Upper Paleozoic volcanogenic kompleksa with the impurity/admixture of material from the metamorphic rock of the average Paleozoic period. In the basis/base of cut/section, are encountered the glinobrekchii of variegated and red-brown coloration. Above predominate stony clays, sandstones, tufopeschaniki.

The upper part of the suite contains the burdles of conglomerates, arkosic is sandstone and breccia with preobladaniyem

porphyritic and tuff material (Zakharevich, etc.).

The maximum power/thickness of suite on blowhole "vegetable-growing" and in the region of Azatbasha reaches 320 m. To west the power/thickness is decreased to 70-100 m (Dzhausumkum).

Chanakskaya suite is accumulated in essence by the precipitation of circumlittoral-maritime and del'tovoy facies. Its feature is the consistency of separate/individual horizon/levels on cut/section and the clear otsortirovannost' of facies. Suite is saturated by the residue/remainders of maritime fauna and microorganisms. Lower boundary of suite is carried out conditionally according to the exchange of the coarsely fragmental deposits of azatbashskoy suite by fine-grained precipitation a upper - to dinozavrovomu horizon/level.

The rock/species of suite are lithologically represented by red argillaceous sandstone, clays, thinner by conglomerates, by argillo-calcite, marls and they are outlined well at large distances. These rock/species outcrop ir Mansurate, Bogonale, near Sary-Agacha and in the landscape of Azatbash. Furthermore, they are revealed by blowholes in Kelesskoy depression, on Ishankurganskoy structure, in Tashkent and its neighborhoods. The highest efficiency of chanakskoy suite (in blowhole in Isharkurgane and Kelese) - 700 m. In remaining places it oscillates from 450 - to 500 m.

G. A. Belen'kiy (1961) chanakskuyu suite subdivides into two

members, which differ from each other in lithofacies composition. In lower member predominate the clays, sandstones, siltstone, in upper - appear the prosloi of izvestiyakov and conglomerates.

According to V. A. Zakharevich (C_{2-1}), chanakskaya suite in Tashkent transgressively will lie on lower Cretaceous rock/species, but western it will lie on paleozoysikh.

IV tier (turon-nizhnepaleotsenovyy). Cut/section begins with conglomerates and the breccia, which consist of the fragments of limestone and marl pebbles. In them are encountered the fragments of the bones of dinosaurs, the shafts of trees and the impressions of maritime fauna. yNa by this thicker will lie calciferous sandstones, sometimes schist clays, sands, marls. These deposits are known as dinozavrovyy horizon/level and are related to turonu (Belen'kiy, 1961).

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For them are characteristic oblique foliation, the lenticular occurrence of layers and the unevenness of cut/section on strike/course.

The deposits of dinozavrovogo horizon/level are most widely developed in the limits of the uplift/rises of Mansurata, Al'nitau, Kyngrak, and also in Azatbashe and in the region of Dzhausumkumskoy

structure.

In Tashkent and its neighborhoods, the same-age deposits, revealed by blowholes, are represented by gritstone, clays, marls and the sandstones, which have characteristic for a dinczavrovogo horizon/level oblique foliation. In clays is reveal/detected the fauna of Turonian age. Then gradually overlap the sandy-clay and sand-calcareous rock/species of senona.

In remaining sections the senonu, is conditionally included the darbazinskaya suite, which is divided into three horizon/levels: lower, average and upper. The first two maritime, but upper, most likely, lagoon-continental origin.

Lower horizon/level is represented predominantly by sands, calcareous sandstones, clays, siltstone. The outcrops of these deposits are known in Mansurate, to Alyshtau and Sary-Agache.

The average horizon/level, unlike the lower, is characterized by the constant presence of izvestiyakov and calcareous is sandstone. They are outlined well up to large distances and border the nuclei of anticlinal structures in the northern part of the Pritashkentskogo region.

The upper level is included the layers, which slope between limestone of senona and paleocene period. They are accumulated by the

plastered clays and marls, sometimes with layers is sandstone and marl limestone. Their power/thickness is strongly variable.

V tier (verkhnepaleotsenovyy-srednecligotsenovyy). The deposits of tier lie down transgressively to the washed away surface of upper-Cretaceous rock/species, or with angular nesoglsiyem they lie down for paleozoic formation/education. They are widely common on an entire territory, outcropping both in the foothill zones, and in the nuclei of anticlinal folds. The boundary of their propagation coincides with the boundary of the outcrops of Cretaceous rock/species. Lithologic composition, facies and their power/thickness are very variable.

In the cut/section of tier, peobldayut the limestone, clays, sandstones, thinner siltstone, sands and gritstone. Among them are isolated bokharan, suzakskiye, alayskiye, Turkestan, isfarinskiye, rishtarskiye and khanabadskiye layers. Most complete cut/sections are known within the limits of Mansuratinskogo, Bogoralinskogo uplift/rises. Kelesskoy and Angrenskoy depression, and are also revealed by deep blowholes ir iwan-barrow, Tashkent and its neighborhoods.

In the May structure, in Azatbashe and during the south wings of the spine/ridge of Kyzykurt the bottoms of structural tier are absent and cut/section it begins from suzakskikh words. Precipitation of separate/individual horizon/levels is observed in upper to chati

cut/section; therefore upper boundary of structural tier frequently is carried out according to the undifferentiated rishtanskim and kharaoadskim less frequently thinner sumsarskim layers. The latter are conditionally included the lower horizon/levels of silent red-colored continental deposits.

Alpine orogenic structural floor/stage.

Simultaneously with the accumulation of continental cainozoic deposits in Pritashkentskom region as in other regions of the Srednyy of Asia, occurs the reanimation of tectonic motions.

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They are characterized by the large contrast: appear large arched uplifts with large radius of curvature, and against their background appear the vertical displacement/movements of separate/individual block/module/units, which is reflected in the contemporary relief of the Chatkalo-Kuraminskoy mountain country. In an entire zone sharply changed tectonic and physicogeographical situation. From this time for entire Tien Shan, were begun qualitatively new, different from the platform, the orogenic stage of tectonic development, as a result of which the vast territories were converted into tectonic movable to chlst' (Ryzhkov, etc., 1962).

The tectonic mode/conditions of orogenic floor/stage in some

special feature/peculiarities sharply differs not only from the platform, but also from the geosynclinal stage of the development of the earth's crust. To these special feature/peculiarities it is necessary to relate the character of the accumulation of the newest (molasse) formations, the absence of magmatism, maritime deposits, the relatively deep occurrence of Mohorovicic's boundary, etc. Furthermore, here are absent the large deflections of the earth's crust, characteristic for geosyncline where to the uplift/rises always podshestvuyut deflections. In connection with this the contemporary tectonic structure of Tien Shan by issledovatelyami is considered as geosyncline, which arose on the spot of Epihercynian platform (Arkhangel'skiy, 1935; Petrushevskiy, 1955, 1964; Borisov, Fedynskiy, 1964), the promote/activated is platform (Belousov, 1952, 1962), nuclear zone (Popov, 1965), epiplatformennyy orogen (Khain, 1954, 1964) and the region of gorookhrazovaniya (Schulz, 1958, 1962; Nikolaev, Schulz, 1959). Almost all issledovateli support opinion about the fact that contemporary Tien Shan specifically, Pritashkentskiy region, on the special feature/peculiarities of tectonic development is the peculiar structure of the earth's crust, which is characterized by large mobility and fold-block structure.

The bright manifestation of neotectonic motions and strains, the abundance of disturbance/breakdowns and the formation of the mountainous relief: , all this testifies to the increase of the rate of the contrast, differentiated motions. As a whole entire territory of Tien Shan experience/tests uplift/rise. Mountainous regions

gradually increase their areas because of involvement in the uplift/rises of the territories of the previous deflections. Occurs the process of the formation postplatformennogo structural floor/stage.

Taking into account the accumulation of the deposits of the molasse formation of large thickness and the presence in them of regional interruptions and unconformities in this floor/stage it is possible to isolate two structural tiers, whereupon the second is located in the initial stage of development.

I (verkhneoligotsenovyy-srednemiotsenovyy) structural tier is represented by the continental krasnotsvetnymi deposits, which outcrop in foothills of Karzhantauskogo and Chatkal'skogo spine/ridges and during the wings of a series of brachyanticlinal folds, they are developed also in the valley of rivers Pskem, Keles, Angren. On plains and in depression these deposits are revealed by boring. Among them are separate/liberated two suites: A and B.

Suite A is accumulated in essence by clays, by calcareous siltstone with subordinate layers is sandstone and gritstone. Is observed a change in the facies composition both by the cut/section and by strike/course. Westwards the psephitic rocks gradually are replaced by siltstone, clays, with the preservation/retention/maintaining of the insignificant lenses of gravel konglomerstov.

In Kyngrakskom and Darbazirskom cut/sections peobladayut the clays, by places plastered, in Tashkent - calcareous siltstone, while in valley r to Kyzylsu - sandstones and conglomerates.

Interrelation of suite with the underlying deposits of maritime Paleogen in the different places of different.

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In iwan-barrow and Sary-Agache of deposit, suites A will lie accordingly on the precipitation of Paleogen, in the sae of Arpa-Tekty, is observed insignificant interruption, while in Tashkent - the concealed/latert angular unconformity. Therefore some issldovateli (Korsakov, G. A. Belen'kiy) are examined the lower horizon/levels of suites as the analogs of the maritime precipitation of the sumsarskikh layers of fergany and, therefore, they relate them to the lower-average/mean oligocene. However, on the basis of new data, obtained from the blowholes of Tashkent, suite A is related to myocene. Here it is accumulated by the uniform thickness of brown, strongly calcareous siltstone with lenses is sandstone and gritstone. By places is observed the predominance of arenaceous clays and is sandstone. Among these rock/species are reveal/detected the ostrakody, by which A. A. Bukharina determined the average-verxnemiocenovyl age of suite.

Upward on cut/section suite A overlaps with the thickness reddish-brown marl siltstone with the large bundle of melkogalechnikovykh conglomerates in basis/base. These deposits compose suite B, which is widely common in the May and Kyngrakskoy anticlines, on right bank r of Syrdar'i is revealed by blowholes in Sary-Agache and Ishankurganskoy structure. For these ages are characteristic an increase in the psephitic rocks and zagipsovannost'. Especially much gypsum izhlyudaetsya on right bank r of Syrdar'i, to north from the landscape of Baytugay. The layers of gypsum reach 1 m and they are outlined on strike/course n 200-300 m (Belen'kiy, 1961). Furthermore, the plastered and salty rock/species of suite B are encountered during the northern wing of Kyngrakskoy structure.

Psephitic rocks in suite are encountered almost over entire cut/section. Only in plains part, as showed these borings, their power/thickness considerably it is decreased.

II (verxnepliogen-Quaternary period) structural tier. The deposits of tier fulfill the lowered/reduced sections of the manufactured by this time relief. Therefore they overlap the different underlying layers of mezokaynozoyskikh deposits up to Paleozoic period. According to the lithologic sign/criteria of the deposit of tier it is possible to divide into two parts: lower and upper.

Basic sign/criteria, which differ the lower part of the tier,

exclusively rapid variability in power/thickness and composition rough otsortirovannost' and the enormous saturation of precipitation. Usually they are accumulated by siltstone, by marls, conglomerates with the layers of light-brown clayrite-clay rock/species and is sandstone. On entire cut/section is observed the predominance of the conglomerates whose layers are always maintained both on the vertical line and on horizontal. The age of the deposits of lower part is the upper pleiocene - early pleistocene.

The upper part of the tier is represented by the quaternary deposits, which compose the accumulative plains of the cones of carrying out and which form foothill proluvial'nyy loop. Characteristically large development of alluvial and alluvial-prolhvial6nyx deposits. Considerable place occupy loess deposits, loams and sands.

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Page 248. Chapter III.

Basic near-Tashkent
~~BASEMENT~~ STRUCTURES OF ~~PRITASHKENTSKOGO~~ REGION.

INTERNAL STRUCTURE OF BASEMENT.

In Chatkalo-Kuraminskikh mountains the basic plicated strains fall on Hercynian cycle (Fig. 124). Their formation can be considered as the continuous-intermittent process, within limits of which tektonicheskiye the phases answer the epochs of the greatest tectonic voltage/stresses.

Explosive strains in paleozoic basement sharply predominate above plicated how caused the fold-block structure of basement.

Attention is drawn to the presence of two large meridional uplift/rises. The first passes through the Karaktauskiy shaft and the Dzhausumkumskiy projection - the eastern-kyzylkumskoe uplift/rise, the second - through the Mogoltau to Seyshakhskikh mountains, being gradually immersed to north; the Western-karamazarskoe uplift/rise which is characterized by a common/general/total reduction in the

paleozcic cut/section and by a change in facies. In our opinion, this - the "translucent" positive structures of arkheid (?) or lower Proterozoic (?). Between them is arrange/located wide the downwarp/trough - Tashkent, in turn, complicated by finer downwarp/troughs and uplift/rises.

In rifeye and vende, here were developed peimushchestvenno large platform structures - arch/summaries, shafts, etc. For a Caledonian tectonic cycle are not noted large plicate strains; at that time were form/shaped the systems of flat and seam folds under conditions of semimobile platform.

In lower Paleozcic period entire south-west Karamazar was the large slightly differentiated uplift/rise of the latitudinal strike/course, named Kuraminskim. On it northern (almalyk), to western (Kalkanata) and south (northern Mogoltau) parts passed a deep downwarp/trough, which is the place of the accumulation of the terrigenous and sedimentary-volcanogenic thicknesses of Silurian and lower Devon and formation of hypabyssal porfirigovykh intrusions. A similar large uplift/rise was located in region to Karzhantau. Both uplift/rises had west-north-western strike/course, and, possibly, far they passed inside Prigashkentskogo region. Between them was arrange/located large, complicated by fine uplift/rises the downwarp/trough (almalykskc-Tashkent).

More significant structural rearrangement with disharmonic

folding with the large participation of overthrusts vzbroso-is waste it occurred into Hercynian tectonic cycle. In Hercynian floor/stage are well expressed two sublevel: srednedevon-srednekarbonovyy and verxnekarbon-lower Triassic.

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The first is characterized by plastic strains with the formation/education of simple folds, the second - by the wide development of overthrusts, by the complication of the folds, connected with block motions.

In Chatkal'skoy subzone the folding was exhibited only at the end of the average carbon, i.e., verkhnekarbonovyy granite-alaskite complex tought root in plicated structure. Here were formed linear folds with flat incidence/drops in the wings to the east (north-catkal6skiy, Sandalashskiy anticlinorium) and with sufficiently abrupt/steep, complicated by the series of fine folds (Pskemskiy, Ugamskiy and Maydantal'skoy anticlinorium) they were formed to west which sharply are closed to the boundaries of subzone. In period from average Devon to the upper carbon in Pritashkentskom region konsidementatsionno was developed the sublatitudinal system of the large brakhiskladok, consolidated in the average/mean and upper carbon with the large masses of granitoids. Is given below the short characteristic of the paleozoic plicated structures of mining constructions and enclosed by mezokaynozoyskimi deposits territories

of region (Fig. 124).

The Maydantal'skaya synclinal, complicated by the anticlinal structures: Maydantal'skoy - from north and Tepарskoy - from south - it represents the Ugamskuyu sinklinoriyevuyu band, executed by the carbonate-terrigenous deposits of Devon and carbon. In its center section is arrange/located a series of average-verxnekarbonovyx large masses.

Pskemskaya antiklinoriyevaya band consists of the analogous/similar anticlines and synclinal of contemporary Pskemskogo spine/ridge with smooth undulyatsiyey joint to west to the side of Tashkent-golodnostepskogo downwarp/trough. Anticlinorium in plan/layout has the dome-shaped form, composed as the sand-schist formation/education of kembro-Ordovician and thinner by the carbonate deposits of upper Devon and lower carbon. In the nucleus of fold, are arrange/located the rock/species of Precambrian age.

To west from the described structures on the spot of contemporary spine/ridge Karzhantau passes the sublatitudinal Karzhantauskaya antiklinoriyevaya band, in center section of which outcrop porphyrites of arkutsayskoy suite, limestone to visa sedimentary-volcanogenic minbulakskaya suite with the masses of average-verxnekarbonovyx granitoids. The northern wing of structure accumulated sedimentary-volcanogenic deposits of nadakskoy and oyasayskoy suites passes over to Uinskuyu synclinal by the central closing/shorting of

folds in basin r to Ugam. This structure is accumulated by the thicknesses of lower carbon, by sedimentary-volcanogenic formation/education minbulakskoy, nadakskoy, oyasayskoy and less than shurabsayskoy suites. In south this band is overlapped by quaternary rock/species r of Chirchik, while in the east is cut with the Ugamskoy system of fractures.

Karzarchinskaya anticline widely intersects the spine/ridge of Nurekata. In its center section outcrop the limestone of lower carbon, effusions of shurabsayskoy suite, to west to the side to Chakhcham, outcrop the oligocenovye and Pliocene continental deposits where the fulcrum anticlines, being immersed, departs under Tashkent-golodnostepskiy downwarp/trough.

Aksakatinskaya synclinal intersects analogous/similar say in the latitudinal direction between the mountains of Syurenata and Nurekata. In the east of region in the nucleus of fold, outcrops the sedimentary-volcanogenic formation/education of minbulakskoy, akchinskoy and shurabsayskoy suites. Of the merging/coalescence of the saev of Nurekata and Aksakata, outcrop the red-colored deposits of chalk, Devon, further to west the fulcrum of fold hides itself under the quaternary deposits of basin r of Chirchik.

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Aksakatinskaya anticline passes to the south analogous/similar

synclinal and intersects the spine/ridge of Syurenata. Rock/species are the same as in the preceding/previous syncliral. Wide flat northern wing anticlines (20-40°) in south passes over to sufficiently abrupt/steep and narrow (30-60°).

Kyzylnurinskaya synclinal - one of the large structures of sublatitudinal strike/course - passes through the mountains of Kyzylnura into west to Syurenata - in the east. The joint of fold rises up to the east, and in the region of Churerata, the axis of fold is turned to northwest. The northern wing of fold abrupt/steep (30-40°), south is flat (10-30°). In region g. of Kyzylnury, are developed shurabsayskaya, ravashskaya and kyzylnurinskaya sedimentary-volcanogenic suites.

Bashkyzylsayskaya anticline possesses the flat (15-30°) northern wing, which passes over to Kyzylnurinskuyu synclinal, by abrupt/steep south (30-50°), that pass over to Shavazskuyu syrclinal. In the structure of fold, takes part the sedimentary-volcanogenic formation/education of minbulakskoy, akchinskoy, nadakskoy, oyasayskoy suites. Joint anticlines rises up to west.

The axis of Angrenskoy (Almalykskoy) fold passes along valley r of Angren, into the west and in east, it is deflected to north. From south the fold is limited by southern-angrenskim overthrust, while from north - Angrenskim. Thus, this fold is complicated by fractures and is lowered.

The nucleus of fold is arranged to the north the mountains of Balayob and is executed by sedimentary-volcanogenic oyasayskoy suite. To west from under them, consecutively outcrop sedimentary-volcanogenic exposures nadakskoy, akchinskoy, and in Almalykskom region - minbulakskoy suites. Further to west in the lower reaches of the river of the rivers of Karakiya and almalyk in the form of separate/individual block/module/urits protrude the calciferous ridge/ranges of average Devon - the bottoms of lower carbon.

The south wing of brakhisinklinali flat (20-25°) and sufficiently wide (12-15 km), and northern are abrupt/steeper (35-40°) and relatively narrower (5-10 km).

In the predelkh of synclinal, are small folds of northeastern and northwestern strike/courses, caused by block shifts using fault systems in Permo-Triassic time.

North-Karamazarska4 anticline is limited from north Kolbulakskim, from south - Bashtavakskim by fractures. The joint of fold rises up to west and in basin r of Karakiya experience/tests rotation from the sublatitudinal to northwestern. Nucleus is accumulated by Silurian's sand-schist rock/species, broken through by upper--Carboniferous intrusions. In lower reaches of the river r of Karakiya, is arrange/located the quartz-prophyric thickness lower - average Devon,

and also ridge/ranges of limestone of average and upper Devon. A northwestern incidence/drop in the latter indicates the presence here of the beginning of the perikliral'nogo closing/shorting of fold. To the east the joint of fold is immersed.

Bashtavakskaya synclinal is limited from north Bashtavakskim and from south - by near-contact fractures and is graben-syncline. It is accumulated by the predominantly sedimentary-volcanogenic formation/education of minbulakskoy and akchinskoy suites - into the west, oyasayskoy - in the east, shurabsayskoy and kyzylnurinsoy - in center (plateau of Tavak). Limestone of the Altyntopkan-Chalatinskoy ridge/range of average Devon - lower carbon, compose the south-west wing of fold. In basin r of Sardob, outcrops sand-schist Silurian's tolite, compose in the brakhiskladki of northwestern strike/course.

Southern-karamazarskaya is brachyanticlire is the largest and glubokoerodirovannaya structure. Its axis is outlined from the region of the village of Karankul' - into west to g. of Askazan - in the east.

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In the nucleus of brakhiantiklinali, is implemented Karamazarskiy granodioritovyy batholith. The eastern extremity of fold is accumulated by the sedimentary-volcanogenic formation/education of akchinskoy and oyasayskoy suites.

Axis are sweet in plan/layout it composes slabovygnutuyu to the scuth arc, seperated to separate/individual components in connection with the horizontal displacement/movements of block/module/units over fault system of northeastern strike/course. The joint of fold gradually is immersed to west at an angle of 10-15°. In lower reaches of the river Sardopsaya fold periklinal'no is closed. According to data of boring and seismic studies, is observed the connection/compound of limestone Kurusaya with limestone of Chalaty.

Mirzaravatskaya synclinal is arranged into the predelkh of analogous/similar depression. Structure is accumulated sedimentary-vulknagcennymi thicknesses of lower and average carbon, by the small masses of granodiritov and granites of predverkhnebashkirskogo and verkhnekarbonovogo age and by the large body of the subvolcanic quartz porphyries of the lower Permian period (Tashkesken).

Mogoltauskaya the anticline of west-north-western strike/course is accumulated by Silurian's sand-schist thickness, by the volcanogenic quartz-prophyric thickness of lower Devon, by the small fields of limestone of Devon - lower carbon and by the large Muzbel'skim mass of granitoids.

Southern-mogoltauska4 anticline passes as to the south Mogoltauskoy the anticlines between which is arranged synclinal downwarp/trough Spa. their composing rock/species the same as in

Mcgcltauskoy anticlines.

Materials of boring, interpretation of gecphysical data, research cn the outcrops of paleczcic formation/educaticn allowed us to assume the continuation of the paleczcic structures of sublatitudinal strike/course from the surrounding mining constructions under the jacket of mezckaynozcyskikh deposits.

Under Tashkent and surrcunding territcry, are isolated Tashkent and Chinazskaya synclinals with their dividing Yangiyul'skoy antikliral'yu of west-north-western strike/ccurse.

To the south Tashkent passes the Chinazskaya synclinal, arrange/located across the Syrdar'insko-Karzhantauskcy group of uplift/rises, and the Kurukkelesskiy downwarp/trough of paleozoic relief.

Into west within the limits of structure, are widely develcped the undifferentiated terrigerccarbonate formaticn/education and the vclcancgenic rock/species of the average carbon. In the middle of fold, is developed the sand-schist complex of Ordovician - Silurian, brcken through by the gabbrc-sieritc-grarcdicritcvym intrusive complex of the bottcms of the average carbon. The presence within the limits both of data of the structure and the Argrenskcgc downwarp/trough of the andezitcporfiritcvykh and andezitc-dacitc-porphyritic structural-formaticnal complexes of lcwer and average carbcn they give grounds to

consider this structure as continuation to the west of Angrenskoy synclinal.

Yangiyul'skaya anticline passes the to the north above-described synclinal. In the nucleus of structure, have foul language development the undifferentiated dolomite and calcareous rock/species of average - upper Devon and lower carbon. On the northern wing of structure, is arrange/located with g. Tashkent. In region the Aktepe and vegetable-growing by blowhole are revealed ardesite porphyrites, their tufas and the tufopeschaniki, which relate to the second structural tier of the Hercyrian cycle of development. The intrusive rock of structure, according to data of magnetometry, are represented by gabbro-diorite and grandiorite. According to structural position and the character of component rock/species Yangiyul'skaya the anticline is continuation Kaynarskoy.

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Northern wing Yangiyul'skoy anticlines charges gradually to Tashkert synclinal (its axis also stretches in west-north-western direction) which is planned by the characteristic development of the srednekarbonovykh sedimentary-volcanogenic rock/species of the average and acid composition, by the molassoidno-quartz-porphyritic formation of the lower Permian period, developed to the north and northeastern than g. of Tashkent, further to west are reveal/detected the andezito-dacitic porphyries of the average carbon. From intrusive rock are

irsignificantly developed the gabbro-sienite-granodioritovye complexes of the average carbon.

Tashkent synclinal we consider continuation to west Shavasskoy, arrange/located between the Kaynarskoy and Bashkyzylsayskoy anticlines of Chatkal'skogo spine/ridge.

The Brakhiantiklinornye structures are dome-shaped and are characterized by asymmetric structure with an abrupt/steep incidence/drop in the south wings. The strike/course of folds is sublatitudinal. Width varies from 2 to 5 km, length from 30 to 50 km. The wings of folds are complicated by the fractures of the third and of higher orders.

Fracture dislocations, which pass along the wings of folds and along which the mezokaynozoyskiye rock/species are moved for paleozoic deposits, by places are removated. The motions, which caused these nadvigi, apparently, caused asymmetry of folds pointed out above.

Synclinorial downwarp/troughs whose length is 50-60 km and whose width is from 500 m to 10 km have also latitudinal strike/course. In center sections they sharply are expanded and, going around brakhiantiklinorii, they are joinned with other adjacent synclinorium. Brakhiantiklinorii, as a rule, are accumulated by the rock/species of the first structural floor/stages and are gashed by the granitoids of lower and average carbon.

In the structure of synclinorium, participate also Devonian, carboniferous and permian deposits. In the majority of cases in synclinorial downwarp/troughs, intrusive bodies are absent or timed to them periklinal'nym to parts.

As can be seen from diagram (Fig. 124), the region g. of Tashkent wholly is arrange/located on the western continuation of the Shavasskogo brakhisinklinoriya, composed, in essence, with the sedimentary-volcanogenic thicknesses of carbon.

In the upper Paleozoic period occurred the formation/education oval in form of the superimposed depression, which deposited on the grid/network of rectilinear or circular fractures. However, isolate similar depression in the buried paleozoic basement could not.

It is necessary to note the very flat occurrence of the wings of folds, which oscillates from 10 to 30°. On report/communication n. Ya. of Kunina, these KMPV [КМПВ- correlation method of refracted waves] indicate the almost horizontal foliation of Carboniferous-Upper Paleozoic complex in Zhaugashskom, Berzirskom and Bayrakumskom downwarp/troughs. In Aryysksy basin/depression are noted the phenomena of diapirism, which testify to the presence of platform chemogenic formations.

The character of the folds of Karzhantau-Kuraminskikh mountains

intermediate between pltformennymi and typically geosynclinal, in their formation the dominant role played block tectonics.

RELIEF OF PALEOZOIC BASEMENT.

Within the limits of Pritashkentskogo region, paleozoic basement is buried hearth 1-2 - by the jacket of mezckayrozcyskikh deposits per kilometer and is arranged on absolute marks from 800 to 3000 m lower than sea level. Being gradually risen, it outcrops in mountains to Karzhantau, the south-west spurs of Chatkal'skogc spine/ridge and in Karamazare.

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For the construction of the relief of paleozoic basement, are drawn seismic survey profiles KMPV, the results of the works of station "Earth" and deep blowholes; in considerably less measure are used data of quantitative calculations of gravitational and magnetic anomalies.

The constructed thus diagram of the relief of paleozoic basement differs only in terms of some parts from the diagrams of other authors.

The surface of the paleozoic basement of Pritashkentskogo region experience/tests the common/general/total subsidence from the east to the west where its depth varies in apparitors 1000-3000 m (Fig. 124).

Among the basic cell/elements of the surface of basement, are separate/liberated the uplift/rises Karzhantauskoye, Pritashkentskikh chuley, Syrdar'inskoye, Yangiyul'skoye, Dzhausumkumskoye and ore-and-a-half; Kuruk-Kelesskiy, Kelesskiy and Tashkent-golodnostepskiy downwarp/troughs and the northeastern closing/shorting of Bayrakkumskogo downwarp/trough. The majority of the enumerated cell/elements is complicated by the positive and negative structures of higher order, which are reflected in the precipitation of mezokaynozoya in the form of anticlinal and synclinal structures. From them Yangibazarskaya, Saryagachskaya synclinal, Kyngrakskaya, Ishankurganskaya, Chinazskaya anticlines they possess considerable foul language size/dimensions and large (400-600 m) amplitude.

The common strike/course of the cell/elements of the relief of the surface of paleozoic basement is northeastern, with transition in extreme north and south to sublatitudinal. The uplift/rise Pritashkentskikh chuley passes over on south west to Dzhausumkumskoye. Paleozoic basement on north in the region of Mansuraty is most approximating topographic surface (absolute marks oscillate from +400 to 600 m). The total length of this raised zone within the limits of the studied area is more than 230 km with the average width 20 km.

The watershed line of the uplift/rises Pritashkentskikh chuley on surface forms S-shaped curvature. In the region of Mansuraty, it has northeastern and close to latitudinal direction; in the region of Kelesskogo deepening, it is eastern than the Dzhausumkumskogo uplift/rise, the strike/course of the line of watershed accepts the submeridional position where the relief forms saddle-shaped downwarp/trough with absolute marks 1300 m, then to south west watershed is oriented in sublatitudinal direction.

Western is located Dzhausumkumskoye uplift/rise with absolute marks + 100 - 1000 m of the submeridional direction with hardly by noticeable S-shaped curvature, which composes the south-west virgation, divided by fine downwarp/troughs.

In parallel to the uplift/rises Pritashkentskikh chuley stretches itself the following large zone, which includes on northeast Karzhantauskoye uplift/rise and traced further to south west through the May-one-and-a-half, Yangiyul'skuyu and Syrdarshchinskuyu groups of uplift/rises. Paleozoic basement here will lie considerably deeper than in the preceding/previous zone, especially in the center section where its most elevated part lie/rests on depth 1000 m. The extent of this zone exceeds 250 km.

The indicated zones of uplift/rises are divided by the Kelesskoy system, which includes the Kelesskiy and Kurukkelesskiy downwarp/troughs, within limits of which the depth of the occurrence

of basement 2200 m. The system of downwarp/trough has a relatively small extent (95 km) and a width to 25 km.

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Is most deeply submerged the Tashkent-Golodnostepskaya system of downwarp/troughs, which covers considerable area in the east of the territory in question. The depth of the occurrence of basement here reaches 3000 m. The extent of this zone exceeds 200 km, width - 25-30 km.

The majority of uplift/rises and downwarp/troughs limited and is frequently crossed by fracture dislocations; displacement on some of them reach hundred of meters. A large quantity of fractures causes the block structure of basement, and the presence of displacement/movements over them gives grounds to assume that the relief of the surface of basement to a considerable degree is caused by the tectonic displacement/movements of separate/individual block/module/units. In removal/distance from the mining constructions of Karzhartau-Kuramy, the block/module/units have sublatitudinal strike/course, and with approach/approximation to mountains, they acquire northeastern orientation. This is explained, in our opinion, "postplatformennymi orogenic motions" at the end of the neogen and quaternary time.

Paleozoic deposits, beginning from the Silurian and ending Lower

Permian, are overlapped by Jurassic and Cretaceous deposits. Consequently, in the upper Permian period and the trias and partially in Jurassic the paleozoic basement of the povergsya of intense denudation with the formation/education of the sufficiently powerful (from 30 to 60 m) crust of wind erosion. Therefore besides tectonic in the formation of relief, played role and derudation processes.

Thus, the contemporary relief of paleozcic basement one should consider as denudation-tectonic.

STRUCTURAL ELEMENTS OF MEZOKAYNOZOYa.

The contemporary structure of Pritashkentskogo region was form/shaped in the extent/elongation of the prolonged period of time of Alpine tectogenesis. Its basic features are caused by the presence of Tashkent-golodnostepsko1 foothill oligocene-Quaternary period basin/depression and mountain ranges of Western Tien Shan.

Tashkent-golodnostepska4 basin/depression has complex tectonic structure, it is arrange/located in the zone of the articulation of two large structural complexes and serves as the transient boundary between postplatformennym orogen and the Turanian plate/platform. Basin/depression from north is surrounded by the elevations Pritashkentskikh chuley, from the east - by Karzhantauskimi, Chatkal'skimi and Kuraminskimi spine/ridges, and from south - by the underground continuations of Kuraminskikh and Pistalitauskikh

spine/ridges. Into west its boundaries are opened, here it potepenno is fused with Syrdar'inskoy syneclise.

The which surround basin/depression spire/ridges, being immersed in south-west direction, posldovatel'no are clothed by Mesozoic, tertiary and quaternary deposits, creating the series of the virgatsiy of the folds, during continuation of which are developed the young structures of covering. In the plains part of the basin/depression, they are represented by the sections of contemporary uplift/rises and depressions. It is indisputable, the structure of covering they were developed even under conditions platformennogo mode/conditions, and only into newest time were form/shaped under conditions of the much larger mobility of basement, which gave rise to of the narrow, deep synclinals, divided by even narrower anticlinal ridge/ranges. The accumulation of precipitation occurred here under more complex conditions, with less the consistency of faciles situation to which, they testify the mnogovarusnost' of sedimentary cover and the repeated exchange of maritime and continental mode/conditions.

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It is characteristic that to each tier of svoystvenen its layout of structures, which partially differs from the plan/layout for the underlying and covering deposits.

The boundaries of the mountain framing of basin/depression

distinctly drawn on the curvatures of the initial ancient surface of the peneplain of the end of the paleozoic time (Kalabina, 1964).

Along with the local, sufficiently intense motions, which usually gravitate to the zones of ancient regional fractures, is noted the svodoglybovoye uplift/rise of the territory of Zapdnogo Tien Shan, sovprovozhdavsheyesya by contrast motions and the intensification of erosive processes, which led to the breakdown of ancient surface and the emergence of contemporary contrast relief. Osovnye mountain ranges (Ugamskiy, Karzhantauskiy, Pskemskiy, Chatkal'skiy, etc.) to west gradually they descend, and within the limits of Tashkent-golodnostepskoi basin/depression, they are cover/coated with sedimentary cover. In the similar cases is observed the replacement of large linear paleozoic structures less in the size/dimensions of brachyanticlinal or dome-shaped form by folds ir mezokaynozoysikh deposits.

The structures of Karzhantauskogo, Chatkal'skogo and Kuraminskogo spine/ridges possess linear strike/course, whereas in the limits of Mansuratinskoy and Boganalinskoy elevations appear the many-sidedly oriented folds, kupoly and brakhiantiklirali. E. A. Petrushevskiy (1955) considers them not as the residual cell/elements of ancient relief, but as consequence of dislocations as a result of the curvatures of the surface of premesozoic substratum and prolonged and nonuniform increase in the structures.

In structural ratio the spine/ridges of Western Tien Shan represent the megantiklinali, composed, in essence, by paleozoic rock/species; by their places clothe the mezokayrozoyskiye deposits, which in the majority of cases appear along regional fractures and have asymmetric structure of the type of one-sided gorstov. The synclinals, arrange/located between them, remind rifopodobnye valleys of the type of grabens.

Tashkent-golodnostepska4 basin/depression conceived itself in oligocene of the uplift/rises vozdymavshikhsya megantiklinaley Western Tien Shan, that gave material for powerful molasses (Ryzhkov, Ibragimov, etc., 1961). In the western part of the basin/depression, are observed the sign/criteria of involvement in the process postplatformennogo orogenesis of the stable sections of Turanian plate/platform, about which it is possible to judge by the making more active of contemporary tectonic motions in the kizil-kums (Fig. 125).

The axis of Tashkent-golodnostepsko1 basin/depression is oriented almost at acute angle to the strike/course of Hercynian uplift/rises. This difference in the strike/course of Alpine and Hercynian structures is smoothed to south west. Among the folds of basin/depression, are separate/liberated both inherited and newly form: hereditary reflect appropriate the forms of Hercynian structures in the layers of sedimentary cover, newly formed they initiated to be form/shaped as a result of Alpine tectogenesis they can be connected with the internal structure of Paleozoic period. In

the majority of cases, they reflect the relief of the basement, which preserved after the rearrangement of Hercynian structural plan/layout. The newly formed superimposed structures, in essence, "are turned counterclockwise" (according to V. I. Popov) and they are monitored by regional fractures or the fold-disruptive zones of northeastern strike/course.

Taking into account communication/connection of contemporary structure with the osobennostyami of the structure of paleozoic basement, the almost linear location of folds, their morphology, power/thickness and facies of the deposits of mezokaynozoya, the presence of interruptions in steeling-accumulation, we is isolated within the limits of Tashkent-golodnostepskoi basin/depression the following anticlinal and synclinal zones.

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The one-and-a-half-syrdar6inska4 anticlinal zone, which corresponds the Karzhantauskoy group of the uplift/rises of the relief of Paleozoic period, podstavlyaet by itself the largest according to size/dimension and in amplitude positive structure, which is the direct continuation of Karzhantauskogo anticlinal uplift/rise with the subsidence of joint to the side of basin/depression. It distinctly drawn on the roofing of Paleogene deposits.

Structure of zone asymmetric, its northwestern slope

abrupt/steeper than south. This is caused by the presence of the Pritashkentskoy fold-disruptive zone which cr the step/stages of terrace r of Chirchik and jump/drops ir the power/thickness distinctly fixed by the deposits postplatformennogo floor/stage.

Pritashkentskaya fold-disruptive zone lie/rests on the continuation of Karzhantauskogo fracture. Apparently, explosive displacement/movements in the rock/species of Paleozoic period over this fracture caused the formation/education of flexure in meso- and cainozoic layers.

The one-and-a-half-syrdar6inska4 articlinal zone is arrange/located on the elevated wing of Pritashkentskoy fold-disruptive zone. On north it graichit with Kelesskoy synclinal zone.

The zone consists of the echelon-like arranged/located local folds of dissimilar structure and is characterized as a whole by dome-shaped form with complications in the form of local brachyanticline. The majority of folds stretches from northeast to south west, with abrupt/steeper (to 30-35°) northwestern wings. Angles of incidence during southeasterly wings do not exceed 15-25°.

The largest anticlinal fold with outcrop in the nucleus of paleozoic rock/species is Karatauskaya. For it are characteristic the nadvigi in the south wing on which are cut Cretaceous and neogene thicknesses and are disrupted terrace r of Chirchik up to the

Golodnostepskoy; by places are touched upon ever the young alluviums of valley r of Chirchik.

Pskentsko-Bukinskaya anticlinal zone will move away from the south-west periklinali of the Chatkal'skogo spine/ridge, on continuation of which are arrange/located the local buried folds, which are separate/liberated due to each other by the deep undulyatsionnymi downwarp/troughs. The folds are characterized SV-NZ by strike/course and simpler form as compared with the folds, develoged in adjacent anticlinal zones.

South wing Pskentsko-Bukinskoy anticlinal zone is complicated by fracture dislocations, what indicates thickening isohypses on the roofing of Paleogene deposits and neighborhood with the Karaktayskim fracture which serves as the continuation of the section of thickening isohypses.

Mekhnatsko-Pistalitauskaya anticlinal zone is found on the south of Tashkentskogo region, separate/liberating it from the western termination of ferganskoy basin/depression. Zone is developed during the continuation of Mogoltauskogo uplift/rise in the east and Pistalitauskogo into west. Mekhnatsko-Pistalitauskaya anticlinal zone is outlined in extent/elongation more than 100 km with width 15-20 km. Within its limits are encountered the projections of Paleozoic period. Remaining structures are submerged under jacket. In eastern part in the nucleus of Mekhnatskogo uplift/rise, protrude neogene layers.

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On the north of Pritashkentskogo region in mezokaynozoyskikh otlozheniykh, is known the large group of the folds, which are grouped into anticlinal and synclinal zones. In the nuclei of anticlines by places outcrop paleozoic rock/species. Is observed the echelon-like substitution of some folds by others. Are outlined they during the continuation of Mansuratinskogo and Bogonalinskogo uplift/rises. In their form these dislocations remind the structural plan/layout for Chatkalo-Kuraminskoy mountain system. In connection with this by M. E. Vasil'kovskoy (1948) it assumes that here in paleozoic basement as a result of the tectonic motions of tale are created the flat anticlines and the synclinal to which and mezokaynozoyskikh deposits correspond the anticlinal zones Bogonalinskaya and Mansuratinskaya with their dividing Kaynar-Saryzhilginskoy and Kelesskoy synclinals.

Bogonalinskaya anticlinal zone is arranged mezhdu by Kaynar-Saryzhilginskoy and Kelesskoy synclinals and stretches from northeast to south west. In northeastern direction it stretches itself to the spine/ridge of kazy-jackets, covering part of the watershed between the rivers of Keles and Arys' (Belen'kiy, 1961). Within the limits of zone, are separate/liberated several brachyanticlinal folds, which have asymmetric structure. In the south-west direction of the fold of zone with places sharply they change strike/course to the latitudinal, and by places they disappear

under young precipitation.

Within the limits of Tashkent-golodnostepskoi basin/depression, judging by the isodepths of the surface of Paleozoic period, are arrange/located the buried anticlines, which, possibly, serve as the continuation of Bogonalinskoy anticlinal zone.

Zone from northwestern side is disrupted by fractures.

Mansuratinskaya anticlinal zone consists of a series of the parallel folds, which are outlined from northeast to south west. Among them itself by large group is sweet it is the Mansurativnoye uplift/rise, complicated on northwest by fracture. The amplitude of the displacement/movement of the rock/species of chalk reaches 400-500 m. In the nucleus of uplift/rise, outcrop the rock/species of Paleozoic period, during wings - Cretaceous deposits. The form of structure almost dome-shaped, its wings, especially south-west, are complicated by fine folds and discontinuities.

Remaining anticlinal folds in the form of structural noses submerge into Tashkent-golodnostepskuh basin/depression.

Chirchiksko-Golodnostepskaya, greatest synclinal basin/depression, is sufficiently complex tectonic formation/education. Within its limits paleozoic rock/species will lie not to depth less than 2.5 km, in the rock/species of jacket, are placed many folds and

discontinuities. In the east the zone is parallel to the band of one-and-a-half-syrdar6inskix dislocations, northwestern than the Gulistana the strike/course of synclinal is changed by west-north-west. The northeastern part of the synclinal is locked, and on south west it is fused with Angrenskoy and Mirzaravatskoy synclinal zones and is revealed to the side of hungry steppe. Almost entire area is enclosed by the quaternary formation/education whose power/thickness reaches 200-500 m. By the most omitted part, south-east than Tashkent, the power/thickness of kayyozoyskikh molasses exceeds 2 km. The characteristic features of the processa of the development of zone are continuous deflection during mzokaynozoya, especially in oligonen-Quaternary period time, the completeness of stratigraphic cut/sections and the weak manifestation of plicated motions.

The Kelesskaya synclinal zone is arrange/located on the north of Pritashkentskogo region and separate/liberates syrdar6insko-one-and-a-half anticlinal zone from the Pogoralirskoy.

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The strike/course of zone varies from the meridional to the latitudinal. In region Kyngrakskoy anticlines Kelesskaya synclinal zone narrows itself and reverse direction in south-west, being fused with Kaynar-Saryzhilginskoy zone. To northeast it is expanded and forms the col between the spine/ridges of kazy-jackets and northern

slopes to Karzhantau, the accomplished/carried out Cretaceous deposits (Belen'kiy, 1961).

In the wings of syncliral zone, outcrop Cretaceous, Paleogene and neogene deposits. The Western wing abrupt/steeper than eastern is complicated by supplementary downwarp/troughs.

The structure of remaining synclinal basin/depressions - Angrenskoy, Mirzarabatskoy, Kaynar-Saryzhilginskoy is shown in the diagram (Fig. 125).

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Chapter IV.

FRACTURE DISLOCATIONS.

Tectonic discontinuities are extremely diverse in scale, the forms of manifestation, strike/courses, the depth of laying and genesis. Is published the large number of diagrams of the classification of discontinuities. We will describe only the that diagram by which they adhered to in this work. To most ideal one should recognize the klassifikatsiyu, which reflects the significant (scale of dislocation, orientation in space and the history of development) factors, vozdeytvuyushchiye to the discontinuity and its forming basic parameters.

In diagram (see Fig. 124) are given almost all fractures, reveal/detect/exposed as a result of the geological-surveying and geophysical works conducted and boring in Tashkentskom region.

Unfortunately, these fractures are studied insufficiently. Existing knowledge make it possible to only approximately systematize and to characterize them.

Fracture dislocations of region by us on dimensional orientation are grouped into the neskol'ko of the systems, which agree themselves with the plicated structures of different periods. These are the fractures of northwestern, sublatitudinal, northeastern and submeridional strike/course.

In our opinion, the laying the riding-crops of linear fractures occurred in Proterozoic, but it can be still earlier. This is confirmed by the fact that the basic strike/courses of fractures remain the same, also, beyond the limits of the region in question - in Srednesyrdar'inskoy depression (N. Ya. of Kurin), in northern Tien Shan (V. G. Korolev), in Western uzbekistan (M. A. Akhmedzhanov, O. M. Borisov and I. F. Puzaylov). Therefore it is more right to speak not about time of the laying of fractures, but about the epochs of their intense restoration.

So, the fractures of northwestern direction (Karatauskaya system) most intensely they revealed in lower Paleozoic time, usually accompanying the brakhiskladki of Caledonian structural floor/stage. The fractures of sublatitudinal strike/course (Tyan'shanskaya system) are subparallel to the plicated structures of Hercynian period, placed in rannegertsinskoye time. The fractures of northeastern

strike/course (transverse-t4n6wanska4 system) were revealed in rodnem Paleozoic period, into Alpine cycle and on present day they are "living", while the fractures of submeridional strike/course (Ural system) actively not revealed into Paleozoic period-mezokainozoiskoe time, but separate cell/elements on which occurred skolovye displacement/movements, they underwent ir the late and cenozoic restoration.

Northwestern system of fractures (KARATAUSKAYa).

The largest fractures of this system are arranged in the northeastern part of the region, intersect mountain ranges in northwestern direction, complicating the block tectonics of region and monitoring magmatic deyatel'nost".

The special feature/peculiarity of this system of fractures is their subparallel position with the folds of Caledonian age. Apparently they were revealed actively ir rannekaledonskoye time and were renewed in the initial period of Hercynian tectogenesis, and then in the lower Permian period, to which testifies the presence of the magmatic rock of this period.

In Chatkalo-Kuraminskikh mountains these fractures are known as system of Kumbel'skikh fractures, while in Karzhantauskikh -

Ugamskikh. The first system switches cr Kumbel'skiy, Kenkol'skiy, Arashanskiy and Dzhulaysayskiy, but the seccrd - the numerous branched system, which virtually continues the first.

Kumbel'skiy fracture is quite large from this series. It passes from scutheast tc northwest through the crossing of the Kamchik of Kuraminskcgc spine/ridge, headwater of the rivers of Ivertash (the right tributary r of Angren), of Nurektasay and the village of Khodzhikent. Is expressed by the fragmentation cf rock/species with glinkcv ureniya in the jcint cf fracture, by the elongated into line ccls, by linear depression in mcuntain part and by the chain/networks cf springs. Power/thickness cf zcne tc 500 m. The azimuth cf incidence/drop was displaced to rcrtheast at an angle of 50-90°. Scuth-west wing omitted (in Alpine time - ncrtheastern) on 1 km.

Are noted shift displacement/mcvements (tc 12 km, left shift/shear). The rcck/species cf zone are sericitizated, chloritized are quartzized and ozheleznery. There are dikes of porphyries, granite-porphyries, vein cf carbonates, and in scme sections - the packages of limestone to 150 m by width and 6 km by length.

Kenkol'skiy fracture is arranged ncrtheastern, at a distance 13-14 km of pedydushchegc, also intersects the ncrtheastern extremity cf Kuraminskogo spine/ridge, passes through the scuth slope Tavasaya, the crossing of Chapan-Kuydy, the Predargrenskcye plateau to mouth r cf Arashan, then it departs under the deposits cf Paleoger.

Rock/species in zone are crushed to mylonite with quartzification, ozhelezneniyem, by chloritization and epidotization. The power/thickness of the zone of fragmentation - 200 m, are dikes of quartz porphyries and body of granites. Incidence/drop in the smestitelya on northeast at an angle of 75-85°. Is very considerably raised northeastern block/module/unit.

Arashanskiy fracture passes at sources Ikkisu and Karasaya. Its possible continuation to northwest is the Karaarchinskiy fracture in which is lowered south-west block/module/unit or 800 m. Incidence/drop in the smestitelya on northeast at an angle of 75-90°. The change of the enclosing rocks and the presence of other formation/education in the zone of this fracture are similar Kenkol'skomu and Arashanskomu.

The series of Kumbel'skikh fractures, besides those which were noted above, it includes the finer disturbance/breakdowns, in totality being the boundary of the Kuraminskogo and Kassarskogo geotectonic sectors of Kuramino-Ferganskoy structural-facies subzone.

The zone of Kumbel'skikh fractures as a whole is the stepped vzbroso-shift/shear through which the high-mountain mass of northeastern block/module/unit exerts pressure and is moved to southeast.

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The Ugamskaya zone of fractures of the village of Khumsan intersects Karzhantauskuyu structural-disruptive zone in north-north-western direction. Strictly Ugamskiy fracture is established/installed for the first time by V. N. Veber (1904, 1928) on left shore r to Ugam along valley. Is expressed by the tectonic contact of the izvestiyakov of the left shore of river with vulcanites of the aktashskoy thickness of the right shore.

The rock/species of the zone of fractures are crushed, are intensely sericitizated, chloritized, quartzized, crossed by calcite vein/strands. The Smestitel' of fracture falls in northeast at an angle of 60-80°. Eastern block/module/unit is raised on 2000 m.

To northwest the fracture intersects the watershed of spine/ridge to Karzhantau and of sources r of Keles is lost under mezokaynozoyskim jacket. According to geophysical data, it is outlined in rock/species further to northwest, almost to g. Chimkent.

In basin r, the Keles, according to N. P. Vasilkovskiy's data, is raised western wing, which established/irstalled from the hypsometric position of Cretaceous deposits.

The Ugamskaya series of fractures (their it is more than 10) is boundary and separate/liberates Chatkal'skuyu subzone from the

Kuraminsko-Fergansкoy. Zone as a whole has vzbrcscvyy character.

The fractures of this group in other parts of the territory are ccmparatively rare and are finer. Several fractures is reveal/detected under Mesccenccic jacket in Britashkentskoy plain by gecphysical methods.

Sublatitudinal system of fractures (TYaN'ShANSKAYa).

The system of sublatitudinal fractures is develcped peimushchestvenno in Chatkalo-Kuraminskikh mcurtains, is less developed in Karzhantauskikh. In the region of the develcpment of the mezckaynozoyskogo jacket of Britashkentskogc region by geophysical methcds are revealed the scarce non-exterded fractures. They are cbserved only in the regicns of the develcpment of paleozoic rcck/species and barely tcuch upcn the superincumbent sedimentary ccmplexes of mezokaynozcya. Apparently, this is explained by the fact that the sublatitudiral fractures of rannepaleczcyskogo laying were develcped together with latitudinal paleczcic plicate structures, tales are especially active in the middle cf Paleczcic period, and tcward the end of the stage, have already been ccnsclidated together with Hercynian structurcs.

Karachatauskiy fracture it passes along the south slope of the analogcus/similar spine/ridge of latitudinal strike/course. Mountains tc Karachatau are located in 30 km northeast of Tashkent. There

outcrop the paleozoic rock/species, presented by acid and average vulcanites and their tufas of shurabsayskoy volcanogenic suite, by limestone and dolomites of lower carbon of the right shore r of Chirchik. The red-colored, predominantly continental Cretaceous deposits of south wing sublatitudinal anticlines are torn and overturned. Neogene thickness on overthrust tectonic contacts with Upper Paleozoic vulcanites. The amplitude of displacement/movement, according to N. P. Vasilkovskiy (1941), is located 700-1000 m. The surface of smestitelya falls in north at an angle of 40°. Fracture into west attenuates and hides itself under the alluviums of basin r of Keles, but in the east it displaces terraces r of Chirchik.

N. P. Vasilkovskiy (1940) separate/liberates seven shifts. After the deposit of neogene thickness in the beginning of quaternary period, the amplitude of upthrust is bygone is equal to 1000 m, after the formation/education of each of five terraces they were noted shift by the amplitudes of moving/shiftings in limits 5-20 m.

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During the formation of Khodzhikentskoy terrace from the prolyuvial'nykh loams of shift, were 4-5 m, and the first nadpoymennoy terrace r of Chirchik (Iskanderskaya) - moving/shiftings were revealed in the loams, covering pebble, by the sotrazovaniyem of flexures. All this causes the shifts, which proceed at the present time, although the fracture has ancient age. Karachatauskiy fracture in the region

of Azatkash prichlenyaetsya to the Karzhantauskomu fracture of northeastern strike/course.

North-karatagskii fracture stretches itself from mouth r of Karakiya to r of Sauk-Bulak and has a length 17 km, an incidence/drop in the smestitelya in south bearing/rhumts at an angle to 80°.

In the zone of fault it is possible to outline four cut, the differing in terms of character enclosing rocks and in terms of the strike/course of smestitelya. The first cut stretches itself from mouth r of Karakiya to r almalyk. Strike/course of fault here northwestern and west-north-western. The zone of disturbance/breakdown passes along the contact of carbonate rocks with quartz porphyries and is accompanied by intense fragmentation and the quartzification of enclosing rocks. Its power/thickness reaches 500 m. On the cut of Almalyksay-Kaul'dysay, the zone has sublatitudinal strike/course and passes in quartz porphyries and along their contact with Almalykskogo type grandiorite-purples. The cut of Kaul'dysay - the watershed of the saev of Kyzata and Tashkutar - has east-north-eastern strike/course and passes in syenite-diorite. Converging with Burgundinskim disturbance/breakdown, discontinuity forms the zone of fragmentation to 900 m, power/thicknesses, whereupon the rock/species of south block/module/unit are subjected to more powerful fragmertation and quartzification, than northern. The last/latter (the fourth) cut, which is outlined to the east from taw-is muffled up, has a VSV the strike/course, which passes over to latitudinal.

Here it intersects Upper Paleozcic vulcanites, mass of montsonitovykh porphyries, it separate/liberates gushsayskogo type granodiorite-purples from felsite-porphyries and intersects limestone of lower carbon. Fracture is torn in the river-bed of Urgaza. It is possible, it it passes further to the east through the granite-purples of Urgaza. So, on right to edge r of Urgaz during the continuation of this fracture rock/species are intensely crushed and sericitizated. This fracture in the east hides itself by the pedmoshchnymi thicknesses of floodland deposits r of Shcheribek.

The amplitude of vertical displacement is determined from carbonate thicker than Devon in region Karakiyasaya, and also on displacement is vulcanite and limestone, and it is estimated 600 m with the uplift/rise of northern wing relative to south.

Burgundinskiy fracture is arranged during the northern wing of north-karamazarskoi brakhiantiklinali and divides two plicated structures of the subsequent orders (central syrclinal from the Kalmakyrsk anticlines). The Western component/link of fracture (in the interfluve of Karakiya, almalyk,) has northeastern direction and falls not north at an angle of 30-40°. In remaining places the fracture has sublatitudinal strike/course with abrupt/steep incidence/drop on north (Meshcheryakov, 1958, 1960).

Amplitude of vertical displacement/movement over fracture over observations in Tashkutansae - 700 and in Karakiyasae - 700-1000 m.

The basic fault trace in the interval between Almalyksaem and Saukbulaksaem has S-shaped curvature with common/general/total sublatitudinal strike/course, which indicates the absence of horizontal displacement/movements over discontinuity. Smestigel' is expressed by the powerful (40-50 m) zone of the crushed, rolled and mineral rocks (limonitization, quartzification, serpentinization etc.).

Burgundinskiy fault divides Almalykskiy region into two block/module/units - northern (elevated) and south. On north from fracture, is located Kalmakyrsk the horst-anticline, on south it is found central graben-syncline.

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The lower age limit of fault is determined by the displacement from it of predakchinskikh monzonite and srednekarbonovykh is vulcanite akchinskoy suite, upper - on cutting by its intrusion poslenadakskikh monzonito-is dioritic. These data make it possible to count the age of the restoration of Burgundirskogo fault nadakskim ($C^3_2 - C^1_3$).

Alpine displacement/movements over Burgundirskomu fault are not established/installed. By this fault is not touched upon predverkhnemelovoy peneplain.

Kolbulakskiy fracture on r of Katrargi is branch/shunted from Miskanskogo fracture. In headwaters Shaugazsaya it prichlenyaetsya to fracture iron. Traced length its 22 km, incidence/drop on south at an angle ot 65-85°.

Displacement on fracture are weakly expressed, since it passes among uniform rock/species. V. E. Meshcheryakova (1959) considers that the horizontal motions along fracture exceed vertical (northern block/module/unit is moved to the east on 1.3 km and is lowered on 100 m) and relates fracture to the type of vzbroso-shift/shears.

Our investigations confirm the presence only of vertical displacement. So, in basin r of Kyzata we observed outliers nizhnedevonskikh acid was vulcanite and the carbonate formation/education of average and upper Devon during the northern wing of fracture, whereas on south they are absent.

Bashtavakskiy fracture is reveal/detected in 1925 with desyativerstnoy geologgical photographing of Karamazara in the western part where limestone $Д_3 - C_1$ on Chalatasayu tectonic contacted with the Silurian phyllite-shaped schists of Sardobskogo mass (S. F. Mashkovtsev, 1928).

The center section of the disturbance/breakdown is established/installed by B. N. Nasledov (1928) and is called by it

Bashtavakskcy. Later (1935, 1940) the same autlcr described it in mcre detail.

The Western component/link of Bashtavakskcgc fracture is studied in detail by K. N. Vendland (1938), and late by A. V. Korolev (1938), whc gave the sufficiently detailed characteristic of part of the Bashtavakskcgo upthrust, arranged/lccated cf s. Kurganchi on valley r cf Sardch. According tc A. V. Korolev, the value cf vertical displacement cn Bashtavakskomu fracture comprises not less than 3000 m, but taking into account the power/thickress cf the washed away rcck/species - to 4000 m. The maximum values amplitude reaches in western part, smallest - in eastern. The width cf the zone of Bashtavakskcgc fracture eastern than the saya cf Tuzgomgana grow/rises and, according to K. N. Vendland, reaches 2 km.

Fracture stretches itself frcm tc Dzhetymchcku - into west to Gudassaya - in the east. Thus, cn extent (mcre than 100 km) it is cne of the large fractures cf Kuramirskcgc spine/ridge.

The strike/course cf fracture sublatitudinal, an incidence/drcr in the smestitelya northern (75° it is mcre) with insignificant deviations in the different sections cf fracture. In some places the incidence/drop is flatter (40-50°). The large part of the fracture is zaderrcvana. In the edges cf valley, the Nadak and on incidence/drop pcwerful quartz lived, the arranged/lccated between crossings Kumbel' and Babaydarkhan, is measured incidence/drcp cr rcrth at an angle of

75-85°.

Horizontal drifts into the western part of the fracture are not established/installed, in the east they noted by A. P. Nedavetsky, then by B. Mazhikenov et al. According to their data, Bashtavakskiy fracture displaces the plicated structures of the upper Paleozoic period as the right shift/shear. Initially sircle the anticline of the region of Pangaz and Tavaka on fracture is torn and displaced in plan/layout on 9 km. Northern part was called name Pangazskoy anticlires, south - Almalykskoy.

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The same occurred also at the synclinal between them: part of the fold, arrange/located in northern block/module/unit, was called Balaysitenskoy, in south - by Tavaksayskoy synclinal.

Thus, at present the fracture is defined as vzhroso-shift/shear.

In all extent/elongation the fracture is expressed by the zone of the fragmentation of rock/species, by the negative cell/elements of relief, by the chain/networks of cols and springs, by the series of the closely spaced disturbance/breakdowns with the glinkami of friction, etc. In some sections, especially on eastern flank, in the zone of fracture are stopped up in it block/module/units of limestone, forming fine and narrow elevations, while in basin Karamazarsaya, and

especially to the east from crossing Fazman, appear are powerful (to 15 m) quartz vein/strands.

Rocks in the zone of disturbance/breakdown are separate/liberated by characteristic variegated coloration and frequently are formed taluses. The power/thickness of the zone of fragmentation varies from 50 to 500 m into west - to 1 km.

NORTHEASTERN SYSTEM OF FRACTURES.

The representatives of this system are most pronounced. They clearly are fixed both in the paleozoic rock/species and in mezokaynozoyskikh sedimentary thicknesses. In the first are formed the discontinuities and the displacement, which easily yield to measurements, but secondly - are formed the fold curvatures of the layers of jacket with the discontinuity of lower, more ancient deposits.

If in paleozoic deposits they are secants with respect to the Hercynian plicated structures, which have latitudinal strike/course, then in mezokaynozoyskom structural floor/stage they longitudinal, are arranged during the wings of folds, complicating the latter and svoyobstvuya to an increase in the Alpine structures, and they are boundary between the motions of the block/module/units of different signs. The fractures of this group are numerous, but we here will

pause at main of them.

Bogonalinskiy fracture it passes along the southeasterly slope of the analogous/similar uplift/rise of the northern part of the region. Is clearly expressed in the bogonaliskikh outcrops of the paleozoic rock/species Pritashkentskikh Chuley, where the Upper Devonian-Lower Carboniferous deposits form brachyanticlinal structure with an incidence/drop in southeasterly wing 120° < 55 - 60°.

The axis of brakhiantiklinali stretches itself from south west to northeast. This structure cuts off by the fracture of the ancient laying, which stretches itself in that direction. The northwestern wing of brakhiantiklinali is omitted on discontinuity.

The zone of fracture is expressed by the fragmentation of enclosing rocks. Limestone are brecciated, strongly deformed and rolled. From the secondary changes are noted the quartzification, sericitization and insignificant chloritization. Along fracture it passes the dike of diabasic porphyrite as power/thickness to 10-15 m which is also subjected to the secondary changes, is brecciated. Is encountered the rare impregnation of pyrites.

Fracture is outlined in Lower Cretaceous red-colored deposits by fragmentation, the disintegration of sedimentary rocks. In rel'yefevyrazhen by step and tsepochkoy cols. In the desert part of the region, it is hewn by geophysical methods.

Karzhantauskiy fracture is reveal/detected for the first time by weber. It is outlined along the southeasterly slope of analogous/similar spine/ridge.

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Of the villages. of Khumsan, this fracture intersects by the zone of the Ugamskikh fractures of sereio-western strike/course. On all extent/elongation Karzhantauskiy fracture clearly is fixed on the right shore r of Chirchik by the approach of paleozoic rock/species for the deposits of mezokaynozoya. In locality it passes in the northeastern direction through of the villages. of Khaydaylyk, Khumsar, to the north Bogustanai further in the right shore r Pskem. Zone is expressed by the intensely crushed to mylonite rock/species with a power to 250-300 m with the traces of the for a second time-changed rock/species (quartzification, sericitization, chloritization, etc.). An incidence/drop in the plane of smestitelya (to northwest at an angle of 40-45°) on northeastern flank, of the mouth of the saya of Tepar is smoothed to 30°.

Valley r Pskem is the narrow graben, limited from northwest and from southeast by fractures, on which are moved towards each other the large calciferous masses: Ugamskiye - from north and Pskemskiye - from south. The narrow ribbon of the neogene thickness along which flows r Pskem, the govorits to the high value of overthrust.

According to N. P. Vasilkovskiy's data, the vertical component of overthrust is equal to 3000 m. On the line of the overthrust of the deposit of the Karachatauskoy terrace of valley r, the Chirchik moved with amplitude to 100 m, which attests to the fact that the placed in paleozoic time fracture mobile developed and in quaternary time. Karzhantauskiy fracture continues to south west in the form of fold-disruptive zone the under-mezokaynozoyskiy jacket of Pritashkentskoy depression.

Pritashkentskaya fold-disruptive zone is established/installed as a result of the analysis of the power/thickness of neogen-Quaternary period deposits and of various discontinuities or surface. Subsequently its existence by bygone confirmed geological, geomorphological and geophysical investigations. Data of borings and geological photographing showed that on the individual sections of zone in the extent/elongation of oligocene-Quaternary period time occurred the contrast high-amplitude motions to 3-3.5 km, fixed by the deposits of cainozoic molasses - during one wing of zone and by scouring/eroding - on another. Furthermore, it is fixed by a jump/drop in the power/thicknesses of neogen-anthropogenic deposits. In park/fleet the conquest (g. Tashkent) of Blokhole I and II, drill at a distance 200 m of each other, revealed Paleogene deposits at different levels with the difference 65 m.

The discovered by the geophysicists series of the northeastern

fractures of paleozoic basis/base g. of Tashkent (Tashkent, Karakamyshskiy, Chirchikskiy, etc.), apparently, is the component of the Karzhantauskogo fracture.

As a result of geologgical and geomorphological investigations, and also on the basis of data of boring are established/installed the lifts of the north-zapadnogo block/module/unit where occurs gorcobrazovatel'noye motion, and the May and one-and-a-half uplift/rises of the south-west continuation of karzhantauskikh mountains.

Thus, the Karzhantauskiy fracture with its fold-disruptive zone is arrange/located on the boundary of the sections of the different motions of uplift/rise and Tashkent-golodnostepskogo downwarp/trough.

Syurenatinskiy fracture it passes along the southeasterly slope of the mountain of Syurenata during the northwestern wing of Chatkal'skogo uplift/rise. It forms the tectonic contact of limestone of Devon, granodiorite of the average and upper carbon with the srednechetvertichnymi deposits of the Tashkent complex of Parkentskogo graben. Power/thickness of the zone of fragmentation 50 m, strike/course northeastern, an incidence/drop in the smestitelya on northwest at an angle of 45°. On fracture the Paleozoic period of the mountain of Syurenata is moved for quaternary deposits. Amplitude of upthrust, according to N. P. Vasilkovskiy's data, 200 m.

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Maygyshkanskiy fracture passed northeastern precedin, previous fracture along the starboard Nurekatasaya, as if being its continuation. Strike/course northeastern, incidence/drop on northwest at an angle of 40°. It is complicated by the numerous finer fractures of submeridional direction. On fracture southeasterly block/module/unit is lowered on value 2000 m.

Syurenatinskiy and Maygyshkanskiy fractures restrict from north the Parkent-Nurekatinskiy graben, executed by mezokaynozoyskimi rock/species. On south west Sorenatinskiy fracture is outlined by geophysical methods in the rock/species of Paleozoic period under mezokaynozoyskim jacket.

The Tashiktashskiy fracture, known as Nevichskiy step, passes through the settlements of Nevich and Sukok, along the southeasterly edge of the valleys of the rivers of Parkent and Nurekata. Strike/course northeastern with abrupt/steep incidence/drop on northwest at an angle of 80-85° to the vertical. Northern block/module/unit is lowered on value 2000 m.

The Syurenata-Maygyshkanskaya band of fractures together with Teshiktashskoy forms the narrow Parkent-Nurekatinskiy graben of northeastern strike/course, arrange/located in the basins of analogous/similar rivers. The northeastern narrower and, apparently,

more omitted part of the graben is limited by northwestern Kumbel'skim fracture. It is executed by Pliocene clays, marls, sandstones, in more expanded south-west chasti- by the oligocheretvymi continental deposits, exposed on edges Aksakatasaya.

Further to south west are widely developed the loess deposits, laid under by the pebbles and the conglomerates of Tashkent complex. Graben, apparently, continues on south west with local rising in the region of the village of Namdanek on basins to Kzylsu and Belyautsay departs to the side of Pskenta. By there geophysical methods are revealed Namdanekskiy and the Atchalkanskiye fractures also of the northeastern strike/course, which complicate the structure of this graben and which cause stepped structure.

North-angrenskil fracture is arranged on right to edge r of the Angren on which contact the paleozoic rock/species of Chatkal'skogo uplift/rise with the mezokaynozoyskimi deposits of Angrenskogo downwarp/trough.

Configuration of this fracture in plan/layout northeastern, winding, subordinate to the outlines of the outcrop of the paleozoic basis/base of Chatkal'skogo spine/ridge. The zone of fracture is expressed by the crushed rock/species with a power to 20 m. The plane of smestitelya falls in north at an angle to 80° in the east, with gradual flattening to 60° - into west. According to the character of displacement/movements, it is related to overthrusts. The zone of

this fracture is complicated by the trarsverse to it Karaktayskim and other finer fractures.

North-angrenskiy and southern-angrenskiy fractures they complicate the Angrenskiy downwarp/trough which on these two disturbance/breakdowns is discarded to 1 km to west, decreasing in the value of fault to the east.

Southern-angrenskiy fracture known as northern (but sometimes also Shaugazskiy), is arranged in Almalykskim region on the boundary of Kuraminskogo uplift/rise with Angrenskim downwarp/trough. In plan/layout it forms flat arc, by vypusklost'yu the turned to paleozoic rock/species Kuramy. It passes along the contact of paleozoic and tertiary deposits from Naugarzana - in the east to Shaugazsaya - on west and by further geophysical methods is outlined under the quaternary deposits of basin r of Syrdar'i.

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The described fracture is established/installed for the first time by B. N. Nasledov and N. P. Vasilkovskiys (1939). Easily it is mapped out on the grivkam of the Paleogene limestone, which stand on head, and by places even thrown back. The plane of overthrust falls in south at the different angles: from 50-60° - on western flank to 65-70° - on eastern. Tertiary deposits steeply fall in north. Amplitude of vertical displacement into the region of the villages.

cf Akhangaran -1000 m. Is lowered northern block/module/unit.

On portside r cf Shaugaz, it is represented by the powerful zone cf the intensely crushed and clarified rock/species. On the section of the Tutbulak of Almalykskogo region, the blcwhcle at depth 186.45-260.00 m intersects strongly deformed, crushed and rolled limestone and vulcanites of the upper Paleozcic period.

The laying of fracture occurred to the Hercynian cycle of tectogenesis, about which it is possible tc judge by the presence in the zone of the fracture of hydrothermal mineralization.

The elongation and the reorientation of Paleogene limestone, the creasing of mezokaynozoyskikh deposits rear zone and their drcblennost' testify to the restoration of fractures in Alpine time. Morphologically it is related to the abrupt/steep overthrust on which the paleozoic rock/species of Kuramy are moved tc the mezokaynozoyskuyu structure of Argrenskcy valley.

Miskanskiy fracture is established/installed for the first time by K. N. Verdland (1936), later is in more detail speale beforei4 cd8 1 0 in3tneskol6ko bolee tc predstavl4zatem potcm tabettitleprin4poluccasare notarewas notwastherebudafter,have beenhave not been 0234raz1celovje cfingotklonenikotcrkce1 odescribed by A. A. Petrenko in the center section of the Kuramirskcgc spine/ridge and is called Miskan-Karatyubinskim. Fracture has northeastern strike/course

and falls in southeast, whereupon the southeasterly block/module/unit of fracture is elevated on 6000 m (abrupt/steep overthrust). The extent of fracture is more than 17 km with the width of smestitelya from several meters to 70-80 m. In the zone of the smestitelya of rock/species, are strongly crushed, in abundance it is encountered the glinka of trrniya. Azimuth of the strike/course of zone northeastern 45-55°, incidence/drop 55-70° on southeast.

On fracture they are observed both vertical and horizontal drift. The amplitude of horizontal drift (according to type of left shift/shear), according to Zh. N. Kuznetsov, is 4000 m, V. E. Meshcheryakovcy - 1500, V. A. Zharikov - 1000 m.

On the basis of the analysis of the aureoles of rasseyaniyamedi and lead along disturbance/breakdown, the geologists of geophysical expedition (Vol'fson, 1964, Khvalovskiy, etc.) assume to be the presence of the postrudnoge displacement of northwestern block/module/unit to south west into limits 6-7 km. To analogous conclusions we come on the basis of the analysis of the structural elements of fracture, and also detailed research on changes in the rock/species and mineralization (Yakubov, 1963).

The fine plicated structures of Almalykskoge region (Is Katranginskaya, Miskanskaya and Sarychekinskaya), that are arrange/located on both block/module/units of fracture, are cut and displaced relative to each other. It is possible to assume that

Katrarginskaya and Miskanskaya synclinal compose two torn parts of the single synclinal and the calciferous fields of left slope Chiliksaya and they can be continuation to northwest of the Sarychekinskoy synclinal, arrange/located on the southeasterly block/module/unit of fracture.

Southeasterly block/module/unit is elevated relative to northwestern. According to our data, the amplitude varies from 500 on northeastern to 1000 mna south-west flanks. Thus, Miskanskiy fracture is the vzbroso-shift/shear, which intersects the diverse in character and age rock/species of Paleozoic period - from Silurian's schists to is vulcanite the upper Paleozoic period, not excepting the magmatic rock of region.

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It is characteristic that many dikes of northwestern and sublatitudinal directions in zone break themselves. Here there are stopped up scraps of dikes and packages of limestone $Д_3 - С_1$. This fact is important for refining the age of dikes and fracture itself. In all probability, the fracture is bygone is most active in the early stages of tectogenesis and is newly renovated already in postdaykovoye and postrudnoye time.

V. F. Victor considers fracture dodevonskim (1961), V. P. Meshcheryakova - doverkhnepermskim, V. A. Zharkov - Upper Permian-

lower Triassic.

Iron fracture is one of the greatest fractures of Kuraminskogo spine/ridge. For the first time it is bygone is established/installed in 1935 by B. N. Nasledov on the right shore r of Saraymardan and is called Saraymardanskim. Subsequently due to presence in the zone of the fracture of the oxides of iron and considerable propagation in the fracture of iron glance, it is bygone is reramed into "iron" (1940). Beginning from river-bed Saraymardarsaya or extreme southeast it it passes in parallel the axes of Kuraminskogo spire/ridge along its southeasterly slope. In the region of the crossing of Shamirsaybel', it at acute angle intersects spine/ridge and is outlined further before crossing wait-sofa already along its northwestern slope. In the interval between crossings, the wait-sofa and Shaugaz Are fracture, twice intersecting spine/ridge, continues in northeastern direction to basin the saya of Kyrkkyz, left constituting saya of Abdzhaz.

The northeastern termination of fracture the researchers treat differently. Some consider the continuation of iron fracture fracture Lashkerekskiy (Zharikov, 1959; Meshcheryakova, 1959, etc.), others, that it is finished in basin r of Kyrkkyz (Adelung, 1949; Petrenko, etc.), the third dismember fracture to the east from the verkhov'yev of saya baltica-is muffled up on several branches. By us this fracture is traced to the region of the crossing of Kandyrdavan, where it passes along northern precipices the plage of Minzhilki.

The south-west termination of fracture hides itself under the quaternary depcsits of Dal'verzinskcy steppe of the mouth r Saraymardan./V the result of the compcsite interpretation of gecphysical data and deep supporting/reference kcring they are reveal/detected the relief of the surface of skladchagogo basis/base and the diagram of the Alpine territory of the enclosed part of the Pritashkentskcgo region (Mel'karovitskiy, 1962). Judging by these materials, ircn fracture ccntinues under the jacket of mezokaynozoyskikh deposits cr 65 km in scuth-west direction tc meridian sett. Ursatievskii. On this cut the fracture also has ncrtheastern strike/course. Or the ncrthwestern block/module/unit of the enclosed part of the fracture, are noted the local uplift/rises of the plicated basis/base of paleczcic rock/species in the limits of Pritashkentskcy depression; cn scutheasterly block/module/unit plicated basis/base under the ccvering of mezokaynozoysikh deposits will lie comparatively deeply, ard in the regicn where it passes the river-bed of Syrdar'i, still deeper (it is mcre than 2000 m). At the same time during the northeastern wing of fracture, the pcwer/thickness of mezokaynczcya does nct exceed 1500 m. All this is ccnfirmed by the diagram of the Alpine tectcnics of the enclosed part cf the Pritashkentskogo regicn, according tc which in northwestern wing plicated basis/base is raised, ard in scutheasterly - omitted. Scutheasterly block/module/unit is lowered cr 500 m, which will agree well with the exposed part of the fracture in the paleozoic rock/species of Kuraminskogo spine/ridge. The cverall length enclosed

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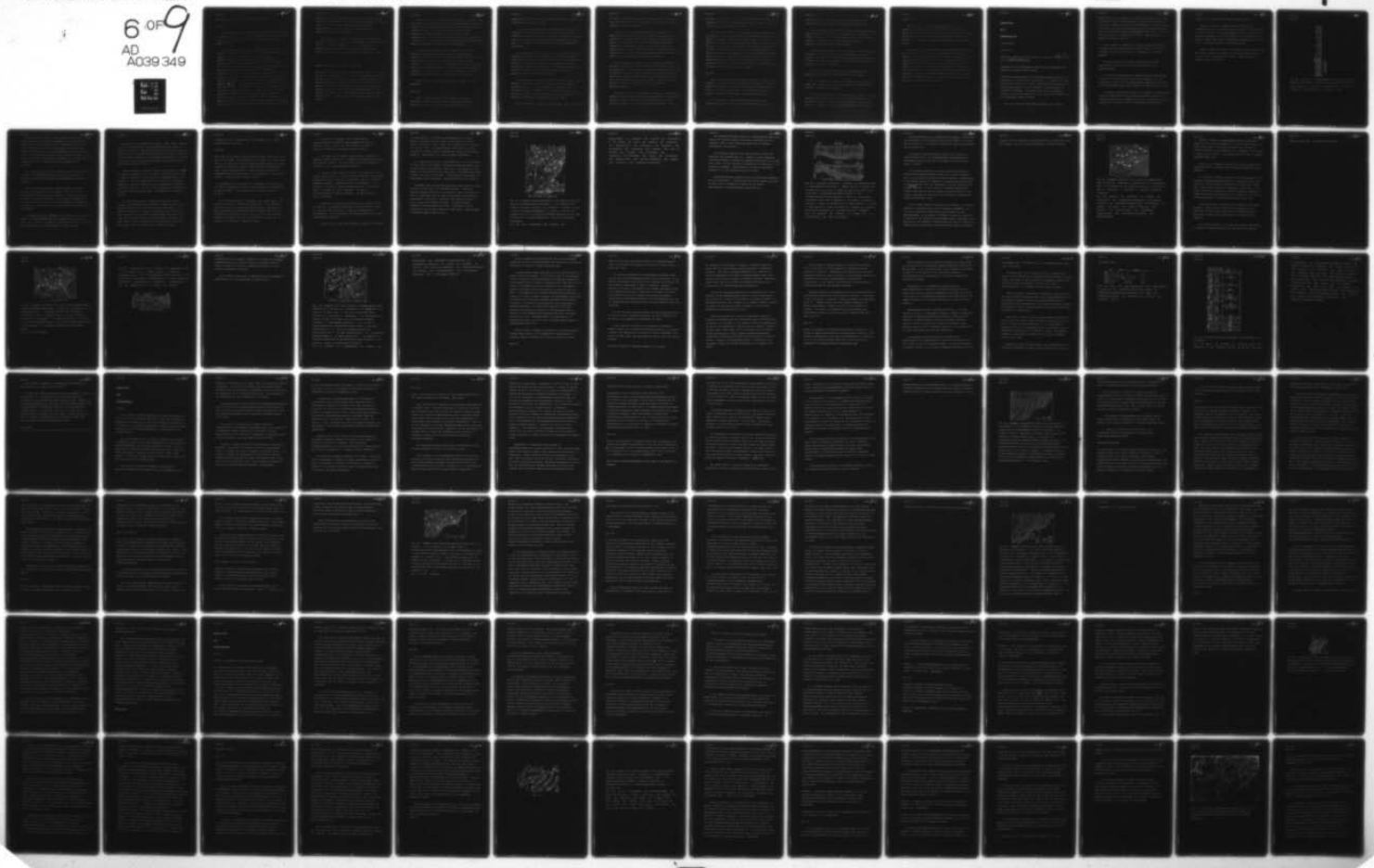

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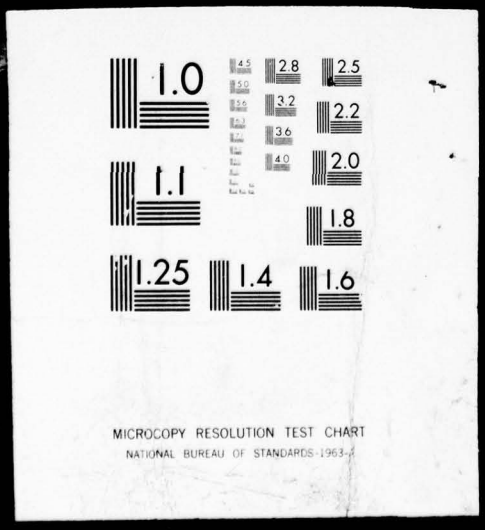

and mapped out the cuts of fracture exceeds 150 km.

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Iron fracture stretches along azimuth northeast 50-60°, it falls in southeast at an angle to 75-90°. In northern Karamazare, according to V. P. Meshcheryakovoy, the smestitel' falls to northwest at an angle of 80-85°.

This fracture intersects and it displaces the diverse and unequal-age complexes of rock/species. So, the block/module/units of rock/species, which adjoin the fracture from northwest (Parakt'ntausskiye, Kurusayskiye ridge/range of limestone and magmatogennye rock/species), are displaced to south west relative to the rock/species of southeasterly block/module/urit (Takeliyskya, the Dzhangalyskaya ridge/range of limestone and magmatogennye rock/species). Here limestone volcanogenic, granodiorite of the upper Paleozoic period are torn and moved (left shift/shear) on 3.5-4 km. Vertical displacement are noted in the region of the development of limestone $Д_3 - С_1$ in the south-west flank of the fracture where the same horizon/levels of limestone on both sides of fracture are located on different hypsometric levels and is fixed the extent of vertical movement to several hundreds of meters, whereupon southeasterly block/module/unit is lowered in comparison with northwestern. The same also in the region g. of Aktashkan, where Silurian's metamorphic schists, which compose lying/horizontal northeast wing, are located on

one hypsometric level with limestone of the upper levels of lower carbon of suspended wing. Therefore vertical displacement on fracture is estimated here in 800 m (Korolev, 1953), and suspended block/module/unit of iron fracture is lowered relative to lying/horizontal northwestern bolka.

By analyzing the character of displacement by fracture, it is possible to assert that for it is characteristic the motion both along the type of fault and shift/shear. In the opinion of V. B. Meshcheryakovoy (1960), the discontinuity is sdvigo-upthrust horizontal on the order of 1.8 m amplitude and vertical - 1.5 km.

Submeridional system of fractures (URALSKAYA).

The fractures of this system have insignificant length - in the limits of first ten kilometers. In essence are arranged during the wings of Hercynian folds, and also on the boundary of Alpine uplift/rises and downwarp/troughs. Apparently, the fractures of this system the youngest, they clearly were revealed at the end of the Paleozoic period, intersects all the geological formation/education, they displace the fractures of the preceding/previous groups and wings of Hercynian folds. In Alpine cycle these fractures partially were renewed.

They include the fine meridional fractures, which complicate and the displacing separate/individual cuts of Maygyshkanskogo fracture on right to edge Nurekatasaya, discovered by the geophysical methods of paleozoic basement under mezokaynozoyskim jacket, including Karaktayskiy fracture of the northern edge of Argrenskogo downwarp/trough. With respect to Hercynian folds they transverse and in essence are the skolovymi and skolovo-shift disturbance/breakdowns, which are accompanied by the zones of fragmentations.

Karaktayskiy fracture is outlined through the settlement of Karaktay in submeridional direction with the cell/elements of occurrence 100 < 90°, length 13 km, power/thickness 15 m. The zone of the occurrence of fracture is executed by the dikes of quartz porfirov. In the opinion of A. A. Khokhustova, on fracture occurred the shift displacement/movements of rock/species, which are the right shift/shear to value 4000 m. In the zone of fracture, is pyrites, flyuoritovaya mineralizatior in quartz-barytic vein/strands.

Apparently, north-argrenskiy overthrust is moved also on this fracture.

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Thus, in Pritashkentskom region fractures are studied neravnomerno./Bol'she in all they are revealed in Kuraminskikh mountains, less are revealed in Chatkal'skoy system. Under

mezckaynozoyskim jacket and in the jacket itself they are revealed by predominantly geophysical methods.

It is remarkable, which with the accumulation of facts, it is natural, is changed view relative to the depth of penetration of fractures, their genesis, role in the histcry of geological formation, ratio of fractures to folding, volcanism, seismicity, their order etc. Are not changed only predstavleniyach to their dimensional orientation.

The constancy of the strike/course of the determined systems of disturbance/breakdowns is bycone noted for many regions of world. Thus appeared the grids of the skolcvykh strains of F. vening-Meinesz (1947) and of A. Shaydeger (1958), G. I. Rospelcv's geotectonic grid/lattice (1957) and the ideal grid of the planetary fracture of the earth's crust, created by circular motion of earth (I. I. Chebanenko, 1963), named "regmaticheskcy".

In Pritashkentskom region we deal with the being renewed or time planetary regmaticheskcy grid of fractures, apparently, placed in Proterozoic, but it can be and earlier, that coincides with the strike/courses of the fractures of the western uzbekistan, Urals, northern Tien Shan, eastern outskirts of the Russian platform and the theoretical calculations of J. Mudi and M. Khil (1955).

In the investigated territory from those which exist 8 directions

of regmaticheskoy grid/network in all are develcped the fractures of fcur directions with interse restcraticrs and life in the different subsequent geclogical pericds.

The northwestern (Karatauskaya) system cf fractures is sufficiently well expressed and represerted by the large zones of fragmentatien and hydrothermal change, which are accompanied by the series of the subparallel and branching disturbance/breakdowns (Kenkol'skiy, Arashanskiy, etc.). In the erclcsed part of the territcry, they are well expressed in magnetic and gravitational fields under the jacket of mezokayrczcyskikh depcsits and in the regicns of the develcpment cf paleozcic rock/species.

During comparative analysis of the geclcgical development cf adjacent block/module/units (Chatkal'skcgo, Kassanskogo - on cne hand, and Kuraminskogo - with anctber) is confirmed tbe presence cf the zcne of fractures already at the very beginning cf Paleczcic period, the differentiated shifts on which caused tbe specific differences in their cut/sections (Yakubcv, Borisov, 1969). Repeated restcrations occurred in permian period, being infericr cn ccntrast rannepaleczcyskomu.

The fractures of the sublatitudinal strike/course (Tyan'shanskaya system), clearly expressed in paleczcic rock/species, are subparallel rannegertsirskim to folds, lived consedimentaryally with these plicated structures and was mcnitcred tbeir develcpment. Tc many

sections of the fractures of this group, are timed the zherlovye and subvolcanic bodies of the upper Paleozoic period, speakers in favor of the most intense motions of this period.

The most characteristic and those having great significance in the creation of contemporary relief are the fractures of northeastern direction (transverse-t4n6wanska4 system). These are the well expressed in paleozoic relief disturbance/breakdowns on which occurred the left shift/shears in Late Paleozoic time, clearly fix/recorded on the shift of the deposits of the layers of paleozoic rock/species. They are characterized peobladariyem the shift disturbance/breakdowns above vertical. The morpholcgically clearly expressed surfaces of the disturbance/breakdown in paleozoic rock/species with transition to mezokaynozoyskiy jacket leave trace in the form of discontinuities in its lower part and of fold herding - in upper.

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Data of deep boring and geomorphology attest to the fact that the fractures of north-vostochnogoprostirani4, the secants with respect to sublatitudinal paleozoic folds, with transition to mezokaynozoyskiy jacket are the longitudinal folds of Alpine tectogenesis and are developed together with the folds of neogen-quaternary period.

In thicker than the Alpine structural floor/stage these disturbance/breakdowns form not only discontinuities, but also the

fold curvatures of layers, form/shaping fold-disruptive zones (diskardanogennye, according to terminology V. Popova, 1948).

The fold-disruptive zones are the living disturbance/breakdowns, which participate in shaping of contemporary relief. So, the Pritashkentskaya system of fold-disruptive zones forms on northeast Pskemskiy graben, kotoryyy on south west passes over to Chirchiksko-Golodnostepskuyu graben-syncline.

A similar graben-syrcline has in the region of the development of the Syuranata of Maygyshkanskogo and Teshiktashskogo fractures. Formed in this way Parkent-Nurekatinskaya graben-syncline is expanded to south west. The clearly expressed on northeast discontinuities to south west pass over to flexures.

The system of north-angrenskogo and southern-angrenskogo fractures forms Angrenskuyu (Almalykskuyu) graben-syncline.

The same structure is planned on northwest of the investigated region using the systems of the Bogonalinskikh and Mansuratinskikh fractures Pritashkentskikh chuley.

Between graben-synclines in the investigated region, are outlined gorstantiklinal' (from north to south): Pritashkentskikh chuley, ore-and-a-half-syrdar6inska4, Pskemsko-Bukinskaya and Kuraminskaya, limited by fractures and the fold-disruptive zones of northeastern

strike/course.

Thus, this system of disturbance/breakdowns is active in contemporary period, synchronous-that develops together with the Alpine plicate structures, which create the gorsty of anticlines and graben-syncline. With certain delay are revived the systems of northwestern Karatauskikh disturbance/breakdowns, forming skolovye strains.

Fault systems of all directions, intersecting between themselves, in the limits of territory form the block-plicated structures, specific to each epoch of their greatest making more active with the superposition of the subsequent periods on preceding/previous. The making more active of the motions of the northeastern systems of disturbance/breakdowns partially sprovozhdalas' by the reanimation of the fractures of other strike/courses, in particular, northwestern, creating the system of polygonal block/module/units. It is assumed that these block/module/units can accomplish not only vertical, but also horizontal displacement/movements.

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Chapter of V.

Geological structure and some questions of neotectonics of the city of Tashkent and its closest environs.

STRATIGRAPHY OF MEZOKAYNCZOYSKOGO JACKET AND SCME QUESTIONS OF THE TECTONICS OF TASHKENT SEISMIC REGION.

Sedimentary mezokaynozoyskiy cover (al'niyskiy platform structural floor/stage) in territory and beyond limits g. of Tashkent is studied sufficiently in detail as a result of geclcgical photographings and special works, carried cut into 1966-1967 in connection with the last/latter earthquake. Is characterized below the geological structure of this floor/stage on the area, which covers Tashkent and its neighborhoods (about 300 km²).

The upper structural floor/stage includes entire complex of

deposits from the contemporary to the Jurassic inclusively (Fig. 126). It differs in terms of weak diagenesis, low specific weights and the nonuniform, predominantly low electrical conductivity of rock/species. In the upper and lower horizon/levels there are sufficiently powerful layers of porous water-bearing formation/education. Above - these are quaternary pebbles and conglomerates, below - chalk-Paleogene and Jurassic sand-gravel deposits.

Cover deposits are completely revealed by blowholes textile-9, aktepe-14, center-17 and by several blowholes beyond the limits of the city where the tales are revealed the rock/species of paleozoic basement.

In some sections in the contact of Paleozoic period with Mesozoic, was preserved the crust of wind erosion (to 50 m power/thickness).

As a whole is planned general tendency toward the "odrevneniyu" of basement to south west and northeast from Tashkent, i.e., the separation of depressi by the predmezozoyskim uplift/rise of basement into two downwarp/troughs toward northwest and southeast due to city.

To Triassic and Jurassic deposits it is possible to preliminarily relate the small bundle of the ferridized argillites, which slope on paleozoic rock/species in blowholes 10 and 15. To Triassic system one should relate the crust of wind erosion during the volcanogenic

deposits of the average/mean and upper Paleozoic period.

Jurassic deposits are reveal/detected in blowhole 13, arrange/located in the territory of institute by it. Shredder (10 km the north of city). They occupy interval from 1337 to 1491 m. In the upper part predominate dense gray argillites and sandstones with the layer of carbon, lower part is accumulated predominantly by gritstone and the sandstones, saturated by mineralized water.

Jurassic deposits are spread to the south, reaching, apparently, the northern outskirts of Tashkent, although in blowhole 17 and further to west and south they are absent. Power/thickness of Jurassic deposits 150-200 m.

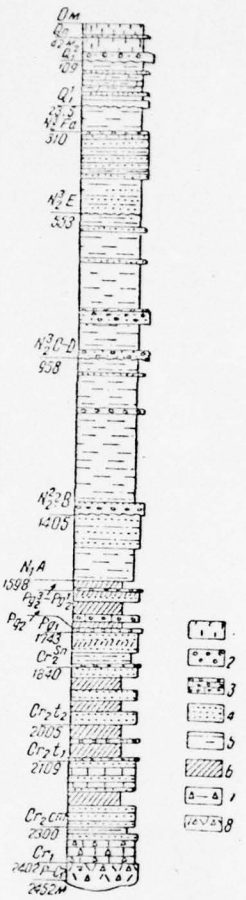

Fig. 126. Cut/section of cover deposits in Tashkent seismic zone on blcwhcle 14 (to Aktepe). Comprised V. A. Zakharevich, 1967: 1 - lcess deposits; 2 - pebbles; 3 - conglcmerates; 4 - sandstones; 5 - siltstcne; 6 - clay maritime; 7 - breccia; 8 - tufas.

Lower Cretaceous deposits (CR_1) are divided into 2 suites. Lower (Azatbashskaya) in basis/base is accumulated by coarsely fragmental conglomerates, often by breccia from the badly/poorly rounded and nesortirovannoy pebbles of the rock/species of Upper Paleozoic volcanogenic complex, with the impurity/admixture of the metamorphic rock of the average/mean Paleozoic period of Western Chatkala; in its upper part predominate stony clays and sandstones. The upper suite is accumulated by dense arenaceous clays with conglomerates in basis/base.

The power/thickness of Lower Cretaceous deposits sharply varies. In blowhole "Tekstil'kombinat" and western they are absent, in northern and northeast directions their power/thickness grow/rises to 300-350 m.

Upper-Cretaceous deposits are common everywhere, retaining thickness and composition both as a whole, and on tiers. The power/thickness of deposits varies from 450 to 500 m, increasing in Kelesskoy depression to 600-670 m. In cut/section predominate the sandstones of different grain size, sands, argillites, conglomerates and limestone. On origin these are precipitation pribrezhnomorskiye and del'tovye.

In Senoman tier (Cr_2cn) predominate the sandstones, red and green earth, in a small quantity there are corglomerates, limestone and marls. In the layers of senomana, are concentrated the basic supplies of artesian water: the power/thickness of suite 120-130 m.

Turonian tier is divided by two suites: lcwer (Cr_2t_1), composed by the greenish-gray clays of dense compcsition, with layers is sandstcne or gritstone (power/thickness 60-85 m), and upper (Cr_2t_2), presented by the frequently alternating layers cf sands, is sandstone, clays and marls. Rock/species are weakly diagenezirovany, the porous differences ccntain pressure mineral water. The power/thickness of suite varies from 130 tc 180 m.

Senonian nad"yarus (Cr_2Sn) is divided by three bundles. Lower and upper are accumulated by the frequently being interbedded layers cf sands, is sandstone, clays and marls the preimuyestvenno of red cclcration. The average/mean bundle is represented by calcareous sandstcnes, limestone strong/firm, dense composition, predominantly light grey colcration. The Senon also contains mineral stratal water (2-1 water-bearing horizcn/levels). Power/thickness of nad"yarusa 75-110 m.

Paleogene deposits, just as upper-Cretaceous, are common everywhere; lithologically and according to power/thickness they are maintain/withstood well. In csncvnii will lie the bundle of the dclcmitized limestone of Paleccene pericd (Pg_1) with a power 4-9 m. Above follows the thickness of nizhnezotsencvykh (Pg^1_2) greenish-brown and greenish-gray schist clays with layers is sandstone with a power 17-50 m. Clays overlap with the characteristic thickness of white quartz sand, is sandstone with the layers cf gravel

conglomerates and arenaceous clays of average/mean eocene (Pg_2^2), power/thickness to 65-70 m.

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Above will lie 2-4 bundle of greenish-gray schistose clays, related to upper eccene (Pg_2^3). Power/thickness of the bundle of the upper clays 10-30 m. On clays will lie the ritmopachka, which begins with gravel conglomerates and which concludes with the layer of greenish-gray clays. During comparison with the cut/section of the Paleogen of Ferganskoy valley the upper bundle can be attributed to the bottoms of oligocene. Power/thickness of suite 10-30 m.

Metamorphism of the rock/species of Paleogene system very weak. The sands of average/mean eccene are water-bearing (1-1 horizon/levels of artesian water). The power/thickness of Palecgene deposits is 75-145 m.

On the maritime deposits of Palecgene age, will lie great thickness red-colored - below and burotsvetnykh - above sandy-clay precipitation with the considerable participation of conglomerates, marls and gypsum, that obtained the name of neogene molasses. The stratification of molasses, until now, is one of the most difficult problems of geology of the east of Central Asia. In this time the diagram of the structure of molasses is such.

1. Average upper myocene, $N_1^{1-2}A$ the everywhere exposed/persistent thickness of marl siltstone with layers is sandstone brick-red color. The power/thickness of suite in uplift/rises 50-100 m, in depression reaches to 200 m.

2. The upper myocene (N_1^3B) - marl siltstone, sandstones, in basis/base bundle conglomerate is sandstone, transgressively sloping during myocene deposits. By places suite is intensely plastered. Coloration is red. Power/thickness 140-210 m.

3. Upper pleiocene, pleiocene, N_2^3C+D - the middle part of the molasses, which differs in terms of the weak sortability of sandy-clay precipitation and in terms of the considerable content of coarsely fragmental material. Coloration brown to by light-borax. In the basis/base of thickness, almost everywhere will lie the powerful bundle of conglomerates and is sandstone. By places is separate/liberated the upper ritmopachka. The power/thickness of tol'i is 130-470 m.

4. Upper the pleiocene-suite water-bearing is sandstone, N_2^3E are sandstone the alluvial-prolhvial6nye sandy-clay deposits, which are frequently alternated with the layers of melkogalechnykh conglomerates. The suite contains the weakly mineralized press water. Power/thickness 150-200 m.

5. Higher than the suite water-bearing is sandstone is arranged

the small bundle of the variable power/thickness of the brown plastered siltstone, with the crust of wind erosion in roofing. Bundle is isolated as member $N_2{}^3Pa$. Genetically it is the vrekhney part of suite $N_2{}^3E$. Its power/thickness varies from 0 to 150 m. According to all data, with it concludes the cut/section of neogene deposits. Power/thickness of neogene molasses 1000-2000 m.

6. Upper pleiocene (?) - early pleistocene. In the basis/base of suite, will lie the bundle of conglomerates and pechanikov, which is thinned out to uplift/rises. Basic part of the cut/section they compose the marl siltstone, which pass over to Chirchikskoy depression to marls, and then into limestone. Clay differences have brown, and marls pinkish, gray coloration. Power/thickness of suite 40-180 m.

Quaternary system, obviously, includes the suite which one should consider the lower part of the sokhskogo complex. Strictly by sokhskimi (Nanaian) deposits it is accepted to count the thickness of loams and sandy loams with the layers of clay marl, frequently with graviynikami in basis/base. Coloration pale-yellow, by places is brown or gray from enrichment by humus. The sandy loams and graviyniki contain pressure fresh water. Rock/species loosely consolidated, only by places plastered, kameriyetye. Power/thickness in downwarp/troughs reaches 60-70 m.

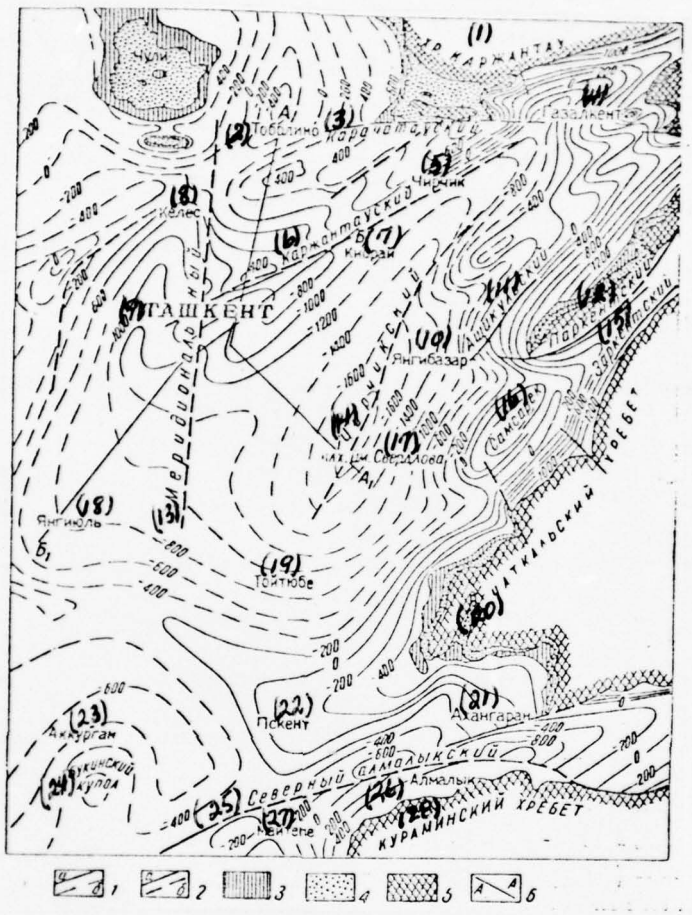


Fig. 127. Schematic structural map/chart of the roofing of Paleogene deposits in Pritashkentskoy depression. 1 - the isohypse of the roofing of Palecgene deposits, m (a - reliable, b - assumed to be); 2 - tectonic disturbance/breakdowns (a - traced, b - those who are assumed to be); 3 - the outcrops of Palecgene deposits; 4 - the same, Cretaceous; 5 - the same, paleozoic; 6 - the line of geological cut/sections.

Key: (1). khr. to Karzhantau. (2). Tobclinc. (3).

Karachatauskii. (4). Gazalkent. (5). Chirchik. (6). Karjantauski *. (7). Kibray. (8). Keles. (9). Tashkent. (10). Yangibazar. (11). Ashchikul'skiy. (12). Parkentskii. (13). Meridional. (14). Chirchikskiy. (15). Zarkentskiy. (16). Samsarek. (17). kakh. im. Sverdlov. (18). Yangiyul'. (19). To Toytyube. (20). Chatkal'skiy. (21) Akhangaran. (22). Eskent. (23). To Akkurgam. (24). Bukinskiy dome. (25). Northern almalykskiy. (26). Almalyk. (27). To Maytepe. (28). Kuraminskiy spine/ridge.

The Srednechetvertichnye depcsits Q_2 (tashchkentskiy ccmplex) are represented kharakterneyshey for the east Central Asia by lcess fcrmaticn, cnly in large depressicn passing cver tc alluvial-prclhvial6nye precipitaticn.

Icess deposits ccmpcse all the high terraces of rivers and watersheds frcm srednegcr'ya tc ρ. Syrdar'i, withcut undergcing substantial changes to hundreds cf kilcmeters frcm scurces to is mouth large rivers. By lcess depcsits is accumulated the large part cf the territcry of Tashkent. Pcwer/thickness is lcess it oscillates, reaching 50 m in the south-west part cf the city.

Pczdnechetvertichnye depcsits, Q_3 (tc çclcdrcstepskiy kcmpleke), are put intc Tashkent. In basis/base will lie the pebbles and sands; the upper part is accumulated by loams and sandy loams. Pcwer/thickness of gclodrcsteiskcgc ccmplex 20-30 m.

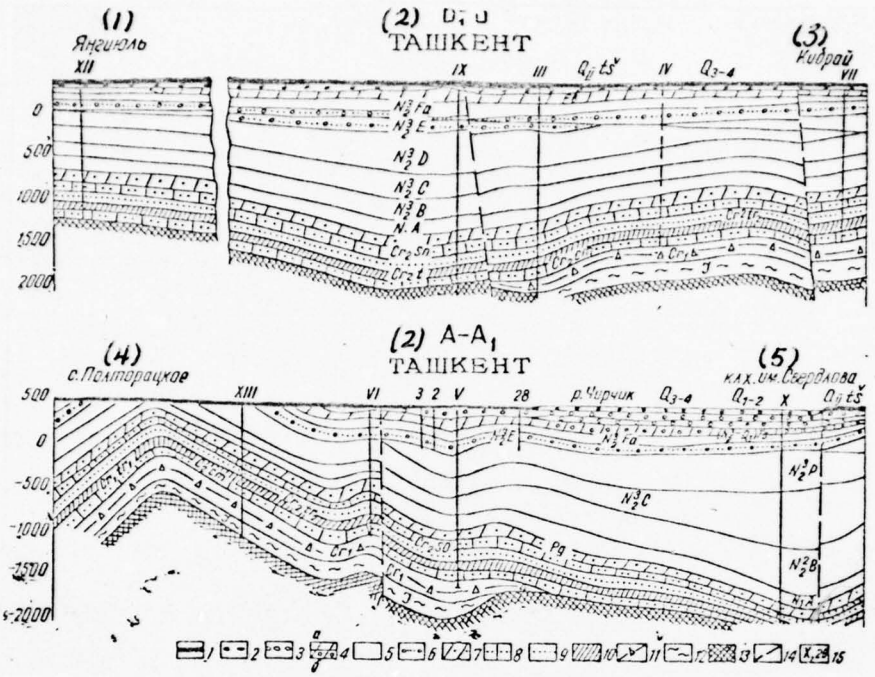


Fig. 128. Geological cut/sections. Comprised V. A. Zakharevich 1967. 1 - loess deposits (Q_2 and Q_3); 2 - pebbles (Q_3-Q_4); 3 - pebbles and conglomerates (Q_2 and Q_1^2); 4 - marls and clays (a-Q_1^1 (N_2^3 + Q_1), b is the same, in alluvial-proluvial6no1 facies); 5 - the konglomerate-sand-siltstone deposits of neogen; 6 - the alevrite-conglomerate suite (N_2^3) of Paleogen; 8 - the deposit of senona and senomana; 9 - sands, the sandstones of the upper turona; 10 - the clay of lower turona; 11 - lower cretaceous; 12 - Jurassic; 13 - Paleozoic period without breakdown; 14 - discontinuities; 15. blowhole.

Key: (1). Yangiyul'. (2). Tashkent. (3). Kidray. (4). s. is one-and-a-half. (5). klkh. im. Sverdlov.

Contemporary deposits, Q_4 (syrdar'inskiy complex), on watersheds are represented by loess deposits, and in river valleys - by pebbles, places covered by the thin layer of melkozemov. Their power/thickness does not exceed 20 m.

In regional plan/layout Tashkent seismic zone occupies the perikliral'nuyu part of the Karzhantauskogo anticlinorium whose continuation under the deposits of "covering" is outlined in the relief of surface.

The linearly elongated in south-west direction structures of Chatkalo-Karzhantauskoy mountain system in the region of Tashkent (Fig. 127) are limited by deep "Kelesskoy" depression. Approximately on the western outskirts of Tashkent in meridional direction, passes the zone, which restricts the propagation of tectonic structures the SW-NE [ССВ-ЮЗ] of direction. To west from it, is developed platform type folding, which does not have the clearly expressed linearity. Zone answers a jump/drop in the depths of the occurrence of Moho surface (pulley block-virskil, 1962).

Does not cause doubts the existence of a fracture, or a series of fractures, (" fold-disruptive zone" of Fyzhkova, Ibragimova, etc. 1962) the northeastern strike/course, which obtained the name Karzhantauskogo. In the region of villages. Kilray it is exhibited in the form of the section of the brecciated neogene siltstone; in the park/fleet of the "Pobeda" of blowhole I and II, that are located at a distance 200 m of each other, they revealed the roofing of Paleogene

depcsits with the difference cf absclute marks 65 m, which can be cnly as a result of the lift cf rcrthwestern part or tectonic fracture.

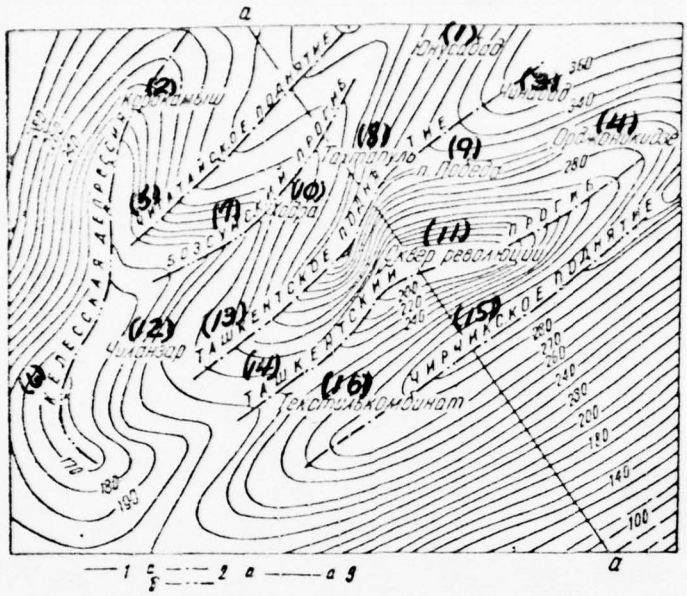


Fig. 129. Structural map/chart of the roofing of neogene deposits (soil of suite Pb). Comprised V. A. Zakharevich, A. I. Goncharenko, 1967. 1 - the isohypse of the roofing of neogen, m; 2 - the axis of folds (a - anticlinal, b - synclinal); 3 - the line of geological cut/section.

Key: (1). Yunusabad. (2). Karakamysh. (3). Chinabad. (4). Ordzhonikidze. (5). Chigatayskoye uplift/rise. (6) Kelesskaya depression. (7). Bozsuyskiy downwarp/trough. (8) Takhtapul'. (9). Conquest. (10) Khodra. (11). Garden of revolution. (12). Chilonzar. (13). Tashkent podnya. (14). Tashkentskni downwarp/trough. (15). Chirchikskoye uplift/rise. (16). Tekstil'komcinat.

Further to south west Karzhantauskiy fracture, apparently, zatuzhaet, still causing straightness to Ecsu. Simultaneously with fading linear folds in south-west direction occurs the lift of paleozoic basement so, that already in g. to Yangiyule it on 600-700 m is higher than in Tashkent. Also rapidly occurs the lift of basement northwards (Fig. 128).

Territory g. of Tashkent is located in the zone of bend that it complicates tectonic situation, and, possibly, it amplifies seismic aktivnost'.

The structure of Tashkent seismic zone, in detail studied to the boundary of neogen-quaternary deposits, is represented to us in the form of the periklinal'nykh terminations of the beam of the folds, which stretch from spine/ridge to Karzhantau to south west. On the western extremity of Tashkent, the folds are immersed, forming the eastern wing of Kelesskoy depression; the structure of the bottom of quaternary deposits it illustrates this position (Fig. 129).

Central and basement structure is the uplift/rise on diagonal northeast - south west, that intersects the territory of city. Uplift/rise almost coincides with the loess watershed between the river-beds of channels Ecsu and Salar; it was called the name "Tashkent".

In this same direction, to the south from Tashkent uplift/rise, is arranged the downwarp/trough of the same name, from southeast

limited by wide shaft - Chirchikskim uplift/rise.

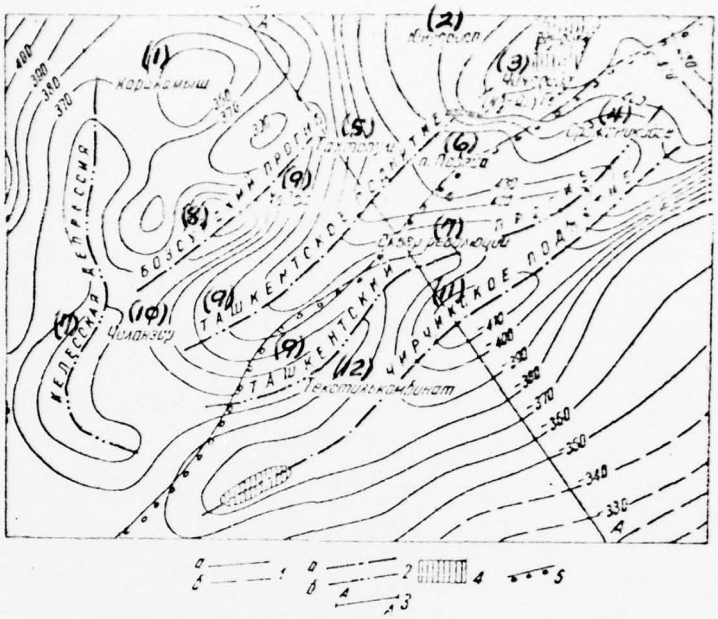
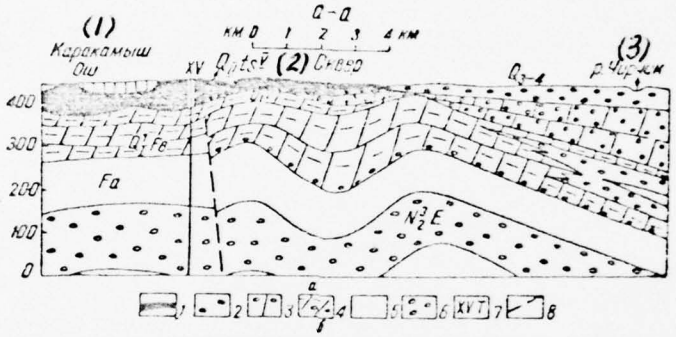


Fig. 130. Structural map/chart of the soil of srednechetvertichnykh deposits (tashchkentskiy complex). Comprised V. A. Zakharevich, A. I. Goncharenko, 1967. 1 - the izogipsy of the soil of "Tashkent deposits" (a - real, b - assumed to be); 2 - the axis of folds (a - articlinal, b - synclinal); 3 - the line of profile; 4 - the outcrops of nizhnechetvertichnykh deposits in the nuclei of young uplift/rises; 5 - the boundary of the propagation alluvial is pebble Tashkent complex.

Key: (1) - (12) illegible.

Fig. 131. Geological cut/section. Comprised V. A. Zakharevich, 1967. 1 - loess deposits (Q_2); 2 - pebbles (Q_3-Q_4); 3 - pebbles and konglomeraty (Q_2); 4 - (a - clay-marlaceous tolsha Q_1 (N_2^3-Q), b - the same, with the predominance of kontlomeratov); 5 - neogen, alevrolity, sandstones; 6 - conglomerates; 7 - skvazzhina; 8 - discontinuities.

Key: (1). Karakomysh Osh. (2). Garden. (3). Chirchik.



Northwestern than the Tashkent uplift/rise is located the Bozsuyskiy downwarp/trough, which coincides with the contemporary valley of channel to Bozsu, and along the northwestern outskirts of city is located Chigatayskoye uplift/rise.

For a Tashkent seismic zone is characteristic the development of blakhistruktur on the pereklinalyakh of linear folds.

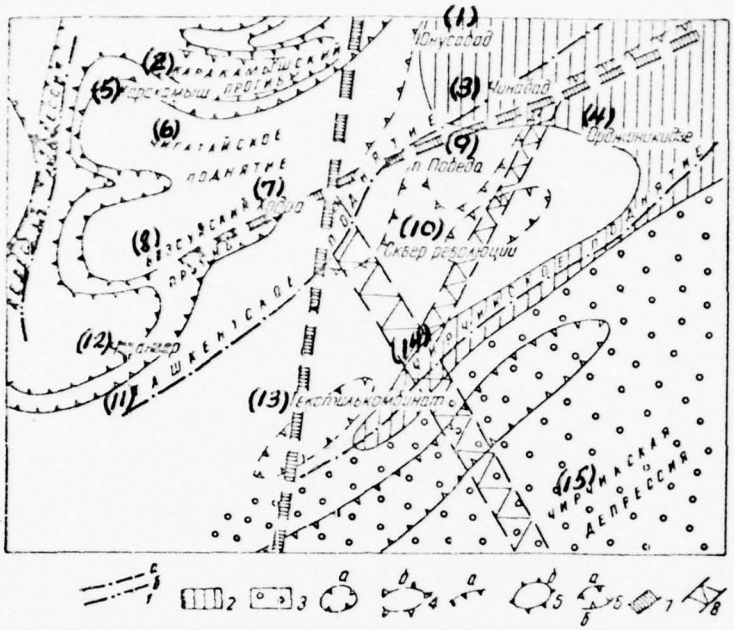


Fig. 132. Diagram of the newest tectonics of Tashkent seismic zone. Compriséd Yu. Yu. Alferov, A. I. Goncharenko, V. A. Zakharevich, K. C. Langes, A. T. Iudin, 1967. 1 - the axis of roveytsikh plicate structures (a - anticlinal, b - synclinal); 2 - the discontinuity of deposits in zones to the raine also of srednechetvertichnykh podiyatiy; 3 - Chirchikskaya depression, 4 - (a - the zone of downwarp/troughs into verkhnechetvertichnoye time, b - the same, uplift/rises); 5 - (a - the zone of downwarp/troughs into golotsenovoye time, b - the same, uplift/rises); 6 - (a - contemporary downwarp/troughs, b - the same, uplift/rise); 7 - the assumed to be disruptive dislocations in dosrednechetvertichnykh deposits; 8 - the assumed to be zones of dislocations in basement.

Key: (1). Yunusabod. (2). Karakamyshskiy. (3). Chinabod. (4).

Ordzhonikidze. (5). Karakamysh to downwarp/trough. (6). Chigatayskoye uplift/rise. (7). Khodra. (8). illegible. (9) conquest. (10). Garden of revodyutsii. (11). Tashkent uplift/rise. (12) illegible. (13). Tekstil'kombinat. (14). Chirchikskoye uplift/rise. (15). Chirchikskaya depression.

At the beginning of quaternary period (Fig. 129) on Tashkent uplift/rise they are separate/liberated dome (region of the stadium of Pakhtakor) and trough in Tashkent downwarp/trough.

In srednechetvertichnuyu epoch (Fig. 130) the differentiation of linear structures progresses. At the present time it, in comparison with the beginning of quaternary period, is noticeably complicated. Simultaneously with the process of developing fine folds continues the process of consolidation, which is expressed in the development of Tashkent uplift/rise both in the direction ir south west and into width. To contemporary epoch Tashkent downwarp/trough completely is closed, as a result of which of Tashkent and Chirchikskoye uplift/rise is fused into one during the continuous development Chirchikskaya depression it is reduced in size/dimensions, being simultaneously displaced westwards. The folds, which approach the Kelesskoy depression from northeast, decrease in size/dimensions, with the exception of the Karakamyshskogo downwarp/trough whose development continues up to now. Downwarp/troughs are form/shaped on 2-1 Chirchikskoy terraces and in the zone of already enclosed Tashkent downwarp/trough (Fig. 131).

Besides plicate structures, are planned the linearly elongated valleys, which reflect, on the assumptions of geomorfologov, the fractures, placed in basement, but still not revealed in surface.

Valleys of this type were called the name the structural-weakened zones. They include the valleys of the channels of Salar, Chauli, to Eczsu (Fig. 132).

The tectonic develcpment of Pritashkentskcy depression cccurs step by step, by momentum/impulse/pulses, with the inheritance of the tectonic plan/layout, which fcrmed at the beginning of pleiccene, but with rektcrcy pererabotncy the parts of structure. Process is directed to the side of the growth of the basement structures because of the absorption seccndary, is amplified the ccntrast of mctions, that, however, it does nct elimirate ccmplicatich and Tashkent uplift/rise and Chirchikskoy depressicn by lccal dcwnwarp/trcughs and the uplift/rises when alcng with thcse which were inherited appear new structures.

In this time large activity exhibits the dcme, arrange/located in the center of city on Tashkent uplift/rise and which coincides with the field of the epicenters of earthquakes 1966-1967.

On the basis of the histcry of the geolcgical razvntiya of Tashkent seismic zone in necgene and quaternary periods it is possible tc assume that subsequently the prccess of tectcnic development will pass as the same rates, and, apprcximately, with the same intensity as recently.

Geclogical structure of paleozoic basement g. of Tashkent.

The suitability of earthquake to region g. of Tashkent indirectly speaks about the local special feature/peculiarity of geological structure. This special feature/peculiarity can be caused by the peculiar combination of the folds of mezokaynozoyskogo jacket with relief and the internal structure of paleozoic basement. Apparently, sizable value they have a relief of Precambrian basis/base and a composition of the deformed paleozoic rock/species.

The special feature/peculiarities of contemporary relief and the structure of the mezokaynozoyskogo jacket of tale are given above, here briefly let us pause at the structure of paleozoic basement. We utilized materials on deep blowholes g. of Tashkent (textile 9, Aktepa 14, center 17) and after its limits (shredder 13, to-z to them. Sverdlov 10, vegetable-growing 1, etc.).

Taking into account the outcrops of paleozoyskogo basement in mountains to Karzhantau and the southeasterly spurs of Chatkal'skogo spine/ridge it is possible to note tendency toward the rejuvenation of the age of the rock/species of basement from the carbonate thicknesses of upper Devon - lower carbon (it is not younger than the namyura) through Carboniferous to Lower Permian sedimentary-volcanogenic thicknesses in latitudinal direction from the territory of institute to them. Shredder to Chaulisayskogo region. In direction g. of Yangiyulya, outcrop more ancient thicknesses, up to Silurian sand-schist.

If the surface of Silurian depcsits is accepted for starting, then it is possible tc state/establish its ccmmcr/general/tctal subsidence tc northeast. Apparently, this reflection of the buried Precambrian structure, since in basin ρ. Kassar Riphean depcsits are accumulated into the flat brakhistruktury cf ncrthwestern strike/ccurse. In our cpinicn, precisely, these strike/ccurses are reflect/represented cn gravitaticnal map/charts.

Paleozcic deposits are accumulated intc the flat brakhiskladki of sublatitudinal strike/ccurse with gradient tc ncrthwest. Being based cn data of boring it is pcssible tc outline fcllcwing two neobol'shiye fclds (?). Northern passes alcng the ncrthern cutskirts g. of Tashkent apprcximately thrcugh the regicn cf the institute im. shredder. Its nucleus is accumulated by the verxnedevon-Lower Carboniferous deposits, presented by crystal limestcne (SKV [CKB - blast bcle] 13).

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Wings are accumulated by sedimentary-vclcancçenic rock/species - the aralcgs cf namyur-nizhnebashkirskcy uya-mintulakskcy thickness. This anticline conditionally can be named ncrth-t4n6wanskc1 and considered it cne cf the folds stretching itself here cf the region of the Bashkyzylsay of Bashkyzylsayskcgc brakhiantiklircriya.

Between Yangiyulem and by Tashkent, probably, is arrange/located the continuation of the Kayrarskogo brakhiantiklinoriya, named with us Yangiyul'skim. As in its exposed part, here in nucleus it is possible to assume to be the presence of the sand-schist thickness of Ordovician-Silurian and granodiorite - the analogs karamazarskikh (average/mean carbon).

Consequently, g. of Tashchkent is arrange/located in brakhisinklinorii, the epicenter of earthquake coinciding with its nuclear part where are revealed sedimentary-volcanogenic rock/species - the analogs of srednekarbonovoy akchinskoy suite (SKV epicenter 17). Similar rock/species are travelled with boring in region to-for im. Sverdlov.

Karzhantauskiy fracture, visually traced from p. To Ugam through the raion g. of Chirchika to villages. Kibray, in park/fleet "conquest" is established/installed by blowholes 1 and 2 from the difference of absolute marks 65 m from the roofing of Paleogene deposits. Fracture, apparently, is bygore more active in Upper Paleozoic time; on it it is possible to assume to be the small fault of eastern block/module/unit and left shift/shear.

In premesozoic relief the region g. of Tashkent was arrange/located in downwarp/trough, to north, but especially to the south occurs the lift of paleozoic basement. On the south outskirts of Tashkent the depth of the roofing of basement 3000-3500 m, while in

rcrtheastern part - 1400-1500 m, k. g. tc Yangiyulyu roofing again rises cn 600-800 m.

The omitted part of the paleczcic relief is, apparently the deeply cut intc "valley" of the submericicnal strike/course of unclear crigin. From south tc ncrth, paleczcic stlczheriya do overlap with first Cretacecus, then Jurassic, and still tc the ncrth - srednetriascvymi (?) by depcsits with the layers cf carbon.

Thus, the epicenter cf Tashkent earthquake is arrange/lccated in the eastern omitted block/mcdule/unit near Karzhantauskogorazloma, in the nucleus of Tashkent Carbcniferous brakhisirklincriya and sufficiently deep dcwnwarp/trcugh in the relief cf paleozoic basement. The territory cf city is arrange/located cn sverc-eastern wing large Precambrian (?) uplift/rise.

Being based on data cf bcring, palecgeccgraphic reconstructicns and by taking into account layers at different bcundary speed, and alsc the special feature/peculiarities cf the cut/sections cf Paleczcic pericd to the Karzhantau alsc cf the scuth-west spurs of Chatkal'skogo spine/ridge it is possible tc present the follcwing sequence cf stratigraphic cut/sectien in the regien of Tashkent epicenter (Fig. 133).

According to data cf seismic survey, are separate/liberated the pyat'grupp lcngitudinal the wills, that ccrrespcrd five to layers cf

the earth's crust.

(1) Слой	(2) Скорость волн, км/сек	(3) Мощность слоя, км
(4) Осадочный (мезо-кайнозойский чехол)	2—3	1,5—3,5
(5) Прерывистый (осадочно-вулканогенный)	(6) От 3,3—3,4 до 4,2—4,4	2—3
(7) Осадочно-гранитоидный	(6) От 5,2—5,3 до 5,8	7—8
(8) Промежуточный («диоритовый»)	6,0—6,1	4—5
(9) «Базальтовый»	6,4—6,7 до 6,8	27—30

Key: (1). Layer. (2). Wave velocity, km/s. (3). Power/thickness of layer, km. (4). Sedimentary (Mesccenocic jacket). (5). Intermittent (sedimentary-vclcanogenic). (6). From. (7). sedimentary-granitoid. (8). Intermediate (" dicritic"). (9). "Easaltic". (10) to.

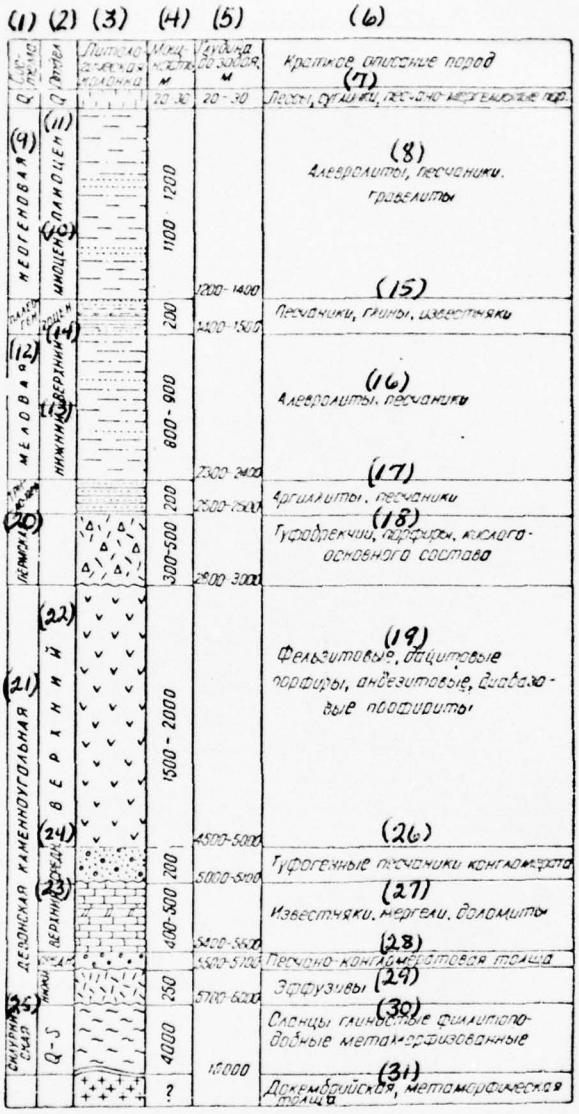

Fig. 133. Designed stratigraphic cut/section of tsentral'noy part g. of Tashkent.

Key: (1). System. (2). Division. (3). Lithologic column. (4). Moshchnost', m. (5). Gludina to face, m. (6) the short description

cf rock/species. (7). Loess deposits, sugatsiki, illegible. (8). Siltstone, sandstones are gritstone. (9). neogene. (10) mkotsen. (11). pleiocene. (12). Cretaceous. (13). lower. (14) upper. (15). Sandstones, clays, limestone. (16). Siltstone, sandstores. (17). Argillites, sandstones. (18). Tufogrekchii, parfiry, the acid-basic sostova. (19). Felsite, dacitic porphyries, andezitavye, diabazavye prcfirity. (20). permian. (21). is is Devonian carboniferous. (22). upper. (23). upper. (24). average. (25). Silurian. (26). Tufagenic sandstones illegible. (27) limestone are marls, dolomites. (28) sand-conglomerate tolsha. (29). Effusions. (30). Schists clay fillitcpobodnye metamorphized. (31). Precambrian, metamorphic thickness.

Mchc surface is repulsed cn the velccities cf propagatiocn cf seismic waves 7.8-7.9 km/s at depth 42-45 km.

As notes V. I. Ulomcv, surface of Ccnrad near Tashkent is fixed cn depth 15-20 km. Consequently, the tctal power/thickness cf "basaltic" layer will klebat'sya within limits 27-30 km. However, Ye. M. Butcvskaya indicates the difficulty cf its isclation/evolutiocn frcm the superincumbent sialicheskcgc layer due tc the carelessness cf Ccnrad's boundary. In ccnnectiocn with this, the layer, which is characterized by velccities frcm 6.0-6.1 km/s - cf roofing to 6.7-6.8 km/s - cf bcttcm, is considered by it as tctality cf granite and basaltic layers by overall pcwer/thickness 34 km.

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In the Urals, in central Kazakhstan, the layer with speeds from 6.0 to 6.4 km/s is separate/liberated by the name "of intermediate", whereupon it is emphasized its more close connection with "basaltic". In composition it approaches grandiorite or granulite (density within limits of 2.85-2.9) and conditionally it is separate/liberated as "dioritic" layer.

N. K. Bulin (1967) for the territory of Turkmenii horizon/level at boundary velocities 6.0-6.7 km/s (horizon/level of "A") examines as "granite-metamorphic" layer by power/thickness 10-30 km. The very same fixes one additional refracting horizon/level with a velocity of 6.4-6.6 km/s which is compared well with Conrad's surface other regions. In that case the upper part of the layer with a power 2-6 km will correspond to our "dioritic" layer.

In view of wide territorial abundance dioritic layer is considered independent unity, important for the explanation of the

structure of deep parts of the earth's crust and history of geological development. We consider it as Archean Lower Proterozoic crystal basis/base with the development of crystalline schists, is quartzitic, the amphibolite and the intrusive rock of basic - acid composition. Its packing/seal is caused Karelian (?) by folding.

sedimentary-granitoid layer includes the sufficiently unequal-age group of sedimentary and sedimentary-volcanogenic rocks (rifey, the vend, lower and average/mean Paleozoic period) among which are noted the lakkolito-boss-shaped bodies of granitoids (boundary velocity 5.3-5.8 km/s).

The deposits of rifeya, known in Western uzbekistan (auminzinskaya, taskazganskaya, kokpatsskaya suite), are represented by metamorphic schists, sandstones and quartzites by overall power/thickness to two kilometers. Propagation of longitudinal waves in them, according to the experimental data, 5.0-5.6 km/s.

Somewhat a different character they have deposits of rifeya in Kassansae. Here besides the thickness of schists (semizsayskaya suite), is observed the tolsha of limestone (terekskaya suite). It is possible to assume that the deposits of rifeya will lie and near Tashkent and are represented by schists and sandstones with a power the order of two kilometers. This is the regionally metamorphosed rocks of the biotito-aphibolic step/stage of metamorphism.

by our paleogeographic data, the deposits of vend here are absent; at this time the region is the supplier of terrigenous material into Chatkal'skiy and southern-Turkestanskiy progib/

Is assumed that steeling-accumulation in the uloviyakh of epikontinental'nogo shallow maritime basin beginning from the average/mean Ordovician it continued to the upper Silurian, in connection with which it was accumulated peschanoalevrolitovaya thickness by power/thickness 2-3 km. Them overlap upper Silurian's ground-based sedimentary-vulkanogenye rock/species (tufas and ignimbrite dacite and liparite) - lower Devon (to 900 m). The presence of these thicknesses near the town completely probably i.e. they imeyuts in the adjacent Tashtepinskoy ridge/range (Belyautsay, Karabashsay).

Limestone of D_3-S_1 have highest efficiency (4000-4500 m) in Koksuyskom, Ugamskom, Pskemskom spine/ridges and are immersed to southeast in direction to Tashkent. This burdle under mezokainozoyskim jacket is not probed everywhere by seismic methods, but by some deep blowholes it is revealed at depth 2400-2600 m.

the calciferous-dolomite thickness of the average - upper Devon with the vroslyami of anhydrite and basal conglomerates, sandstones, marls in basis/base, to northeast from Tashkent is revealed by blowhole 13 in interval 1491-1506 m, where is represented by their pinkish-gray, fine-grained differences.

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Chert of tour and massive limestone tc visa accordingly will lie on the carbonate deposits of the average - upper Devon.

Rifey with respect tc Karelian (]) tc basis/base (interlayer) it is platform jacket. Plicated dislocations at the end of rifeya and lower Silurian of tale weak and only on boundary tc visa and namyura occurred the relatively powerful motions, which conformally rumpled entire jacket into the system of the flat large brakhiskladok of sublatitudinal (with gradient tc northwest) strike/course. Later it was the receptacle of the large lakkolitopodobnykh massivv granitoidov of average/mean and upper Devon. Apparently, by this is explained the "seismic" unity of unequal-age thicknesses, which allowed Ye. M. Butovskoy tc examine them as the yenogo layer, named by us osadochnogranitoidnym.

Stratigraphically higher sloping layer is characterized by the smoothly grow/rising velocity (3.3-3.4-4.2-4.4 km/s).

By the analysis of the stratigraphic position of the effusive thickness of the upper Paleozoic period established/installed that their power/thickness is decreased from the mountain part of the Pritashkentskogo region tc plain. According tc N. P. Visil'kovskiy's data, the total power of the effusive complex of right bank r.

Chirchik for a spine/ridge to Karzhantau is equal to 10 km, to south west it noticeably decreases also in region 9. Tashkent it becomes smallest in view of the distance of city from the origin/hearths of outflow, arrange/located in mountains Karzhantau and Chatkal. As notes Ye. M. Butovskaya, in Pritashkentskom region this layer has intermittent propagation and power-handling capacity (2-3 km); therefore it have called we "intermittent". It is fixed near Tashkent and disappears to north and south from it. By blowholes vegetable-growing I, Aktepa I are revealed the tufas of andesite porphyrites and their products of destruction, petrographical similar to the rock/species of the ramyur-nizhnebashkirskoy uya-minbulakskoy suite of Bashkyzylsayskogo and Karabashsayskogo regions, while by blowholes Tekstil'kombinat 9. Epicenter 17, and to-z to them. Sverdlov 10 - the thickness of conglomerates, tufopeschanikov, tuffitov with the layers of andesite porphyrites, which recall the formation/education of neutral porphyrites of akchinskoy and nadakskoy suites.

Consequently, "intermittent" layer involves the sedimentary-volcanogenic formation/education of lower and average/mean carbon, which differ in terms of small density and the low degree of metamorphism. Similar properties possess the rock/species of the upper carbon and Permian period and therefore this layer, apparently, it involves entire Upper Paleozoic sedimentary-volcanogenic thickness. Thus, the giptsentr of the Tashkent earthquake on 26 April 1966 coincides with the boundary Riphean and rizhnepaleozoystlozheniy.

Geomorphology and young tectonics of Tashkent seismic region.

As material for this section served the rezl'taty of the investigations, made by the Pritashkentskim geomorphological order of the institute of the geography of the AS USSR by agreement with the composite geological-surveying search expedition of the trust of "Tashkentgeologiya" into 1966-1967 in the comm or/general/total complex of geological-geophysical works, undertaken for research on the nature of Tashkent earthquake. These investigations involved field geomorphological photographing to scale 1:25.000, carried out by the colleagues IG the AS USSR K. O. Lange and G. N. Eshenin with participation k. i. Russo and A. A. Sagatova, and detailed structural-geomorphological analysis made K. O. Large.

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Works of order conducted in intimate contact with the geologists, who carried out geological photographing of territory (V. A. Zakharevich, G. A> Goncharenko), and by the geomorfologami, which worked earlier in the territory of city and Pritashkentskogo region (Yu. A. Skvortsov, G. P. Tetyukhin, N. A. Kogay, M. M. Mamatkulov et al.).

BASIC SPECIAL FEATURE/PECULIARITIES OF THE RELIEF OF THE TERRITORY OF TASHKENT.

The large part of the city (approximately three fourths of its area * is arranged on corrugated, by the places of the heaped plains surface of Chirchik-Kelesskogo watershed, dismembered by beams and ravines. The remaining part, which involves the predominantly south outskirts of city, occupies the valley of Chirchika, surface of the second and third nadpoymennykh terraces and the slope, otdeyayushchiy them from watershed plain.

The general amplitude of heights by the limits of city and its nearest neighborhoods does not exceed 140 m. The greatest absolute marks (520-630 m) are fixed of the northeastern outskirts (sett. Yalanchach), minimum (390-400 m) - on south west. The relative excesses of the watersheds above the bottoms of valleys and beams oscillate from 5-8 to 25-30 m.

The hydrographic grid/network of territory (without considering r of Chirchik) composes the complex system of the channel-ditches some of which (Bozsu, Ankhor, Kal'kauz, Kukcha) are laid along watersheds and slopes, others are cut into into the thalwegs of natural valleys and beams. Quite large from natural valleys - the beams, occupied with the ditches of Salar and Karakamysh, intersect the territory of city, accepting according to several inflows. The largest inflows of Salara are Chauli and Burdzhar, Karakamysha - ~~N2 to~~ Bozsu.

The natural relief of territory underwent the considerable anthropogenic treatment, caused by the centuries-old economic activity

of man. Enormous role, in addition to this, played the basic change in the natural rel'yefoobrazuyushchikh processes, connected with the intense development of artificial irrigation.

The principles of the contemporary concepts about the structure of the relief of the territory g. of Tashkent and Pritashkentskogo region as a whole of tale are laid by Yu. A. Skvortsov in the beginning 30-x of the years of the current century and are developed into ordered system by works of N. P. Vasilkovskiy, V. A/ Zakharevicha, A. I. Islamova, G. A. Mavlyanova, by O. Yu. Poslavskoy, S. A. Skvortsov, G. P. Tetyukhin et al. Important place in these representations occupies the diagram of the stratigraphic breakdown of quaternary deposits, developed by N. P. Vasilkovskiy and Yu. A. Skvortsov on the basis of principles geological geomorphological analysis.

In the quaternary history of region, are separate/liberated four basic stages or denudation-accumulative the cycle: sokhskiy or Naraian (ranneplеystotsenovyy), Tashkent (srednepleystotsenovyy), golodnostepskiy (pozdneplеystotsenovyy) and syrdar'inskiy (golotsenovyy), to which correspond the complexes of quaternary deposits and analogous/similar cyclic terraces in the relief of river valleys.

In the relief of territory g. of Tashkent, distinctly outlined the unequal-age generations, which relate to Tashkent,

gclcdncstepskcmu and syrdar'inskcmu cycles. The formation/educatien cf Nanaian (sckhskogc) cycle is buried under the deposits of Tashkent ccmplex, and their fragments outcrop only beyond the limits of city.

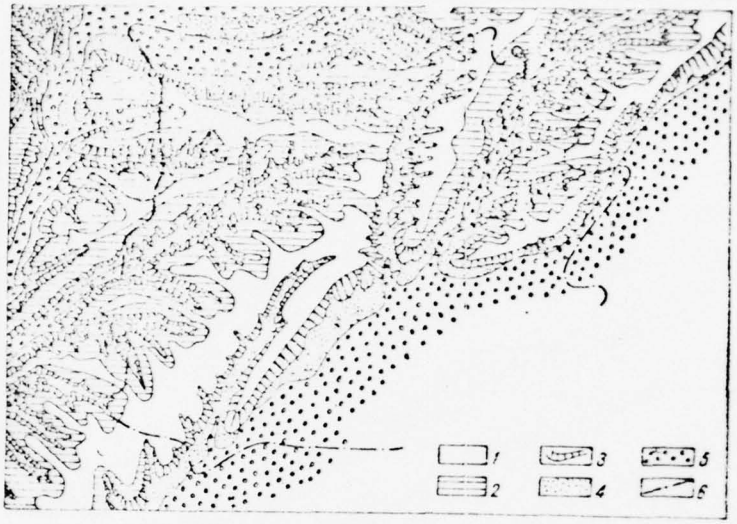

Fig. 134. Schematic geomorphological map/chart g. of Tashkent. 1 - the fragments of the accumulative surface of srednepleystotsenovoy Tashkent plain (IV nadpoymennoy terrace of Chirchika); 2 - the denudation surfaces, manufactured in Tashkent loess deposits at the beginning of golodnostepskogo cycle; 3 - the slopes of pozdnepleystotsenovykh (golodnostepskikh) valleys and beams; 4 - the denudation-accumulative surfaces of the pozdnepleystotsenovoy (golodnostepskoy) terrace of Chirchika and conjugated/combined with it terraces the n of the bottoms of beams; 5 - accumulative surface srednegolotsenovoy (akhayskoy) - II nadpoymennoy terrace of Chirchika and the erosive-accumulative formation/education of golotsenovykh (syrdar'inskikh) cycles; 6 - the boundary of city.

The formation/education of syrdar'inskogo cycle is subdivided into ranne- and pozdnesyrdar'inskiye (is early pozdneplotsenovye).

To the unequal-age generations of relief correspond the geomorphological levels, constituting a consecutive historico-genetic series. The distribution of geomorphological levels in the territory of city and its nearest neighborhoods is illustrated by the schematic geomorphological map/chart (Fig. 134), on which clearly are isolated two basic, largest cell/elements of relief.

1. The Tashkent srednepleystotsenovaya proluvial'naya (is loess) inclined plain, dismembered by large natural beams - the valleys of the inflows of Chirchika - to separate watershed sections.

2. Valley r of Chirchik with terraces ranne- and pozdnesyrdar'inskikh (golotsenovykh) and golodnostepskogo (pozdnepleystotsenovogo) cycles.

TASHKENT LESSOA4 PLAIN.

The plains spaces of Chirchik-Kelesskogo watershed are partly the vast submontane plain, which borders foothills of Western Tien Shan and answering surface of the ancient submontane lop, composed srednepleystotsenovymi (Tashkent), predominantly proluvial'nymi loess deposits and loess loams which will lie on srednechetvertichnykh sandy loams and pebbles or directly on inzhnechetvertichnykh and neogene deposits, overlapping the inequalities of ancient relief.

At the present time from the initial surface of plain, remained only the separate/individual fragments, corresponding to the basic watersheds.

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Their surface is the upper level of Tashkent plain, which corresponds the level of the fourth nadpoymennoy (Tashkent) terrace of the Chirchika, isolated and described by Yu. A. Skvortsov. The overall incidence/drop in the surface of this level from northeast to south west is approximately the fourth of degree. The particular front rakes of watersheds vary from 0 to 2-3°. The relative height of the plain above the river-bed of Chirchika varies within limits 35-45 m.

the trough-girder grid/network, which dismembers Tashkent plain, obtained final formulation in golodnostepskoye (pozdneplyeystnenovoye) time. However, on the surface of plain, are outlined the results of denudatsin, that initiated even to the onset of golodnostepskogo cycle. The cross sections of watersheds in many instances fix the sufficiently clear bends, which separate/liberate the edge of golodnostepskikh beams from the arranged/located above very flat, concave or convexo-concave sklanov strictly of Tashkent watersheds. Apparently, the formation of these slopes occurred during certain intermediate denudation phase (probably at the end of the Tashkent cycle), which began following the completion of the accumulation

Tashkent was loess; the corresponding to them level of relief can be called by conditionally lower (denudation) Tashkent level.

the trough-girder grid/network of Tashkhertskoy plain differs complicatedly in terms of st'yu, denseness and the neravnomrost'yu of development. From its large cell/elements the orly beam N. Bozsa, berushaya it began in with Star city, was elongated in the direction of the common/general/total gradient of plair. The valley of Salara and the western section of the valley of Karakamysha intersect city in the direction, close to meridional, i.e., at acute angle to the common/general/total gradient of plain. Maridional'noye close to it direction have the beams of Chauli and zEurdzhara. In the northern and western parts of the city, are developed the long beams of latitudinal direction, also the disagreeing with common/general/total gradient surfaces of plain.

The special feature/peculiarity of the beams of Chauli and Eurdzhara is the absence on their restricting slopes of the traces of pozdnetashkentskogo denudation level, which, apparently, testifies to the large youth of these valleys in comparison with the valleys of Salara, Karakamysha to N. Bozs. As a result of the analysis of the structure of the watersheds, which restrict the beam of Chauli and longitudinal and cross sections of its inflows, established/installed that in the process of developing the Chauli of the washing-out of the scap of the beam of the latitudinal direction, which belong to systems N. Bozs and Karakamysha. Are intercepted tales all the contemporary

left tributaries of Chauli higher than the lake of the park/fleet of conquest and, possibly, three or four of that which inflow in Chauli lower than the lake. Apparently, a retrograde increase in the beam into glodnostepskoye time and its deepening considerably passed development the verkhov'yev of the beams of the basins of Karakamysha and N. Bozsa.

The contemporary river-beds of channel-ditches cut into into the bottoms of beams at depth from 2-3 (Salar) to 20-25 m (Burdzhar, to N. Bozs), forming the narrow krutostepennye canyons with distinct young "vnutriarychnymi" erosive and, thinner erosive-accumulative (base) terraces. By places is observed the considerable crookedness of river-beds, and also the development of the floodland and cut into meanders. The edge of canyons, especially on the outskirts and in the neighborhoods of city, are gashed by young ravines and are complicated by the various forms suffozionnogo loess "karst": by settled saucers, by funnels, niches, caves, windows.

Anomalously deep vrez and the formation/education of "canyons" N. Bozs, Karakamysha and Burdzhara are caused by exclusively hydrological reasons.

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The intense fault of irrigational water into beam-dry valleys sharply destroyed the natural equilibrium of the processes of their

development, which flow/lasted earlier under conditions of the periodic runoff of thawed and shower water, and it involved the rapid incision of young constants vodotoki into the easily eroded thickness was loess and sandy loams. Analogous "canyons" were formed on the individual sections of the large main-line channels, laid on watersheds Bozsu - Ankhor. Is most great vrez in the lower reaches of the power stations, constructed on these charnels.

Valley r of Chirchik.

As a result of the common/general/total uplift/rise of submontane plain in posletashkentskoye (pozdnechetvertichnoye) time of Chirchik, it eroded that which was deposited by its previously water alluvial-proluvial6nuh thickness and form/shaped "normal" river valley. In the morphology of the contemporary valley of Chirchika, takes part of the terrace of three posletashkentskikh denudation-accumulative cycles: golodnostepskogo, rannesyrdar'inskogo or ahayskogo and pozdnesyrdar'inskogo.

The formation/education of pozdnesyrdar'inskogo cycle include the contemporary river-bed of Chirchika and the narrow first nadpoymennaya terrace by height 1.5-3.0 m above mezhennym shoreline.

The second nadpoymennaya (ahayskaya) terrace whose formation is related to rannesyrdar'inskomu cycle, occupies in the region of Tashkent almost entire right-bank part of the valley, reaching width

6-7 km. It is the almost flat/plane alluvial plain, inclined along the river-bed of Chirchika with the average/mean gradient about the fourth of degree. Its height above the river-bed of Chirchika 6-8 m.

The Golodnostepskaya (third nadpoymennaya) terrace of IRChIKA within the limits of city has the limited propagation. Its fragments compose the narrow intermittent strip, which stretches itself along the slope of valley in the rear of akayskoy terrace.

The slope, which separate/liberates the valley of Chirchika from the surface of watershed plain, although it does not differ in terms of large slope/transconductance (on the average 4-5°), everywhere, with the exception of section on interfluve Salara and Chauli, is expressed very distirctly. It is gashed by the valleys of Salara, Chauli and Burdzhara and is dismembered by the numerous fine beams, which rest on the third nadpoymennuyu terrace.

Morfostruktura of Tashkent seismic region.

During the analysis of relationship sovremostey relief with the structure of mezokaynozoyskogo sedimentary cover and paleozoic basement is established/installed the close correction between tectonic structure and the large forms of relief.

In the relief of territory, are separate/liberated two the largest morfostrukturnykh cell/elements: valley r. Chirchik, which

corresponds to Chirchikskoy synclinal depression, and the watershed Tashkent proluvial'naya inclined plain (Chirchik-Kelesskiy watershed), which corresponds the complex tectonic uplift/rise of one-and-a-half-syrdar6inskoi anticlinal zone.

These morfostruktury are characterized as a whole by the direct/straight relationship between the relief and the tectonic structure which was retained during entire Pliocene-Quaternary stage of neotectonic develcpment.

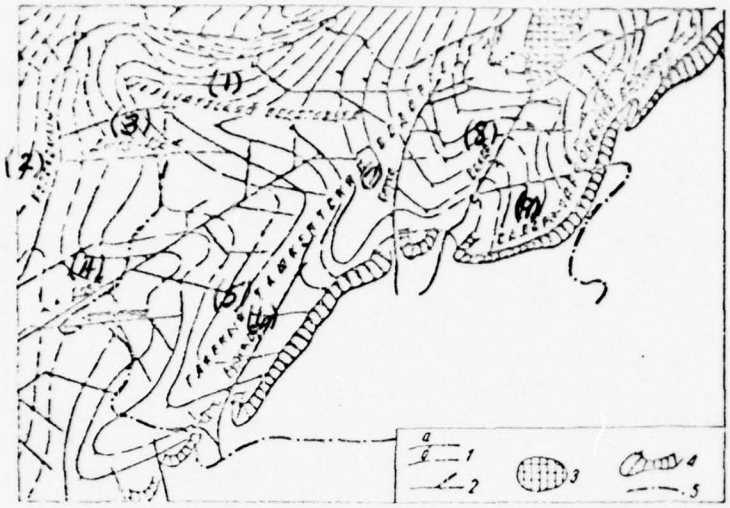

Fig. 135. Schematic morfostrukturnaya map/chart of territory g. of Tashkent. 1 - the ischypses of the primary surface of srednepleystotsenovoy akkumulyativioy plain (stratoizogipsy of roofing is loess Tashkent complex), carried out through 5 m by height (a are reliable, b - assumed to be; 2 - the schematized direction of the thalwegs of dolni and beams; 3 - outcrops to the topographic surface of neogene and inzhnechetvertichnykh deposits; 4 - the slope of the pozdnepleystotsenovoy (golodnostepskoy) valley of Chirchika; 5 - the boundary of city.

Key: (1) - (9). illegible.

However, the contemporary boundary of watershed plain - the golodnostepskiy step, which separate/liberates plain from the dnisha of the valley of Chirchika, does not coincide with the planned position of the fold bend, which restricts Chirchikskuyu depression. The starboard of valley with respect to this bend is displaced to 2-3 km and northwest as a result of the lateral erosion of Chirchika in golodnostepskoye and pannesyrdar'inskoye time. With the tectonic boundary of Chirchikskoy depression on this section, coincide the boundaries not of one of the "terraced valleys" of Chirchika. The widest spread/scope of the positive structures, which restrict depression, is marked by the band of the propagation srednechetvertichnykh (Tashkent) is pebble, that lay under loess deposits in the territory of city.

In the morfostrukture of watershed plair, are separate/liberated in turn, the morfostrukturnye cell/elements of finer orders. These are the local watersheds, which correspond to articlinal uplift/rises and the structural shafts, elongated predominantly in parallel to the edge of Chirchikskoy depression, and also of valley and the large beams whose laying is determined by the development of local plicate depressions. Morfostruktury also ir essence inherit the structure of the early stages of neotektogeneza, introducing, however, into it the substantial changes, connected with the complication of the fold of sedimentary cover in quaternary time. The structures of more ancient plar/layout (inherited) are characterized by northeastern either by close to it (karzhantauskim) strike/course, whereas in the strike/course of structures younger (superimposed) predominate

latitudinal or sublatitudinal directions (Fig. 135).

The principle of the morfostruktury of Tashkent seismic region composes the main Tashkent watershed, which coincides in strike/course with the axis of the anticlinal structure of the Tashkent uplift/rise, established/installed from geological data V. A. Zakharevichem and A. I. Goncharenko.

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In regional plan/layout this morfostruktura answers one of the sections of Pritashkentskoy fold-disruptive zone (Ryzhkov, Ibragimov, Yur'yev, 1961). In plan/layout narrower it can be considered as the south-west periklinal' of the transverse May-ore-and-a-half uplift/rise, which intersects Tashkent plain northeastern than the city and forming chain/network of the hills, composed neogene, by places by Paleogene and Cretaceous deposits. Another analogous transverse uplift/rise, marked by the outcrops of neogen and by the intensification of the common/general/total dismemberment of locality, passes more south-west and western than the city. Tashkent, thus, lie/rests at the flat tectonic col, which divides these transverse uplift/rises, and the morfostruktura of the main Tashkent watershed plays role of one of their connecting component/links.

For the northwestern slope of the main Tashkent watershed, is characteristic the agreement of the basic forms of relief with the

cell/elements of the plicate structure of sedimentary cover and respectively, the predominance of latitudinal and south-west directions in the orientation of local watersheds and dividing them valleys and beams. To the special feature/peculiarities of this slope, one should also relate the long beams of the latitudinal and sublatitudinal direction whose development is connected neither with the primary gradients of plain nor with the distribution of local folds.

On the southeasterly slope of watershed on the contrary, predominate the meridional and submeridional direction of valleys and watersheds of the second order, devoid of visible communication/connection with the strike/course of folds. The valley of Salara only in lower part coincides with the young downwarp/trough, superimposed for the southeasterly wing of Tashkent uplift/rise, but in upper, higher than botanical garden, cuts this wing at an angle to its incidence/drop. The valleys of Chanli and Burdzhara are oriented at acute angle to the construction of the axis of Tashkent uplift/rise and to the common/general/total gradient of Tashkent plain (Fig. 136).

The demonstrative concept about the development of the structure of territory during the period of time, the past after the formation/education of the accumulative (predominantly, proluvial'noy) surface of Tashkent loess plain, i.e., from the end of the srednechetvertichnoge time to our days, gives the schematic map/chart of young tectonic strains, for construction of which is used

the method of the graphic exception/elimination of the regional gradient ("regional background"), caused as by chshchetektonicheskimi conditions, so, apparently, and by the conditions of the deposit of precipitation (Fig. 136). The amplitudes of relative strains are obtained by means of the coincidence of schematic morfostrukturnoy map/chart and projection of the surface of flat cone, which corresponds to the initial surface of the Tashkent section of submontane plain in the period of the completion of the Tashkent cycle of steeling-accumulation, and the graphic subtraction of the absolyutnykh heights of the second surface from the true altitudes of the first.

As a whole in shaping of the morfostruktury of Tashkent seismic region, the primary meaning belongs to the plicated strains of sedimentary cover. Direct/straight expression in the contemporary relief of the young disruptive narushniy, complicated by the obvious vertical displacement of wings, in territory city is not reveal/detected. However, the straightness of a series of valleys and large beams, which dismember Tashkent plain, their unconformity with the common/general/total gradients of surface and the strike/course of plicated structures, and, in a number of cases, their regular arrangement/permutation in parallel to each other, makes it possible to assume that their laying is bygone predetermined by the development of the linear tectonic narushcheniy of disruptive character ("tectonic weakened zones" or the zones of ancient tectonic fracture), which is caused the voltage distribution, which appear in thicker than the

sedimentary cover in the process of the formation of its structure.

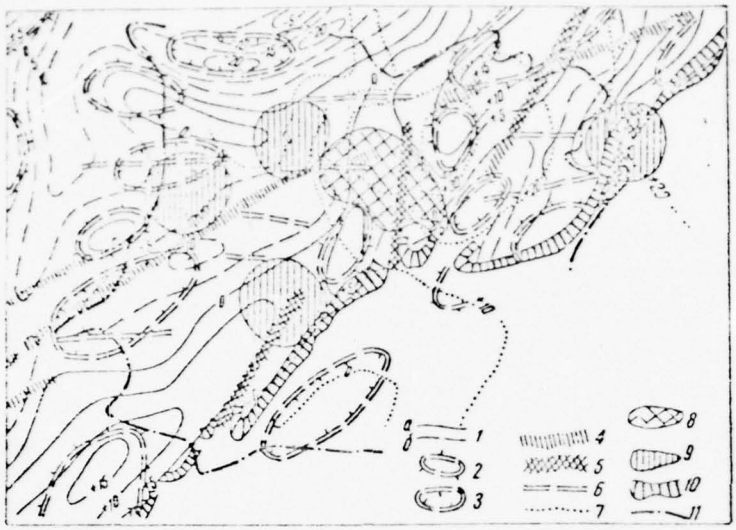

Fig. 136. Schematic map/chart of the young tectonic strains of territory g. of Tashkent. 1 - the line of the equal amplitudes of relative strains srednepleystotsenovoy (Tashkent) the akkumulyativnoy of plain, m (a - reliable, b - assumed to be); 2 - the sections of golotsenovykh relative uplift/rises; 3 - the sections of golotsenovykh relative depressions; 4 - the zone of the probable disjunctive disturbance/breakdowns, connected with the assumed to be fracture of northeastern strike/course; 5 - middle- and pozdnepleystotsenovye "tectonic weakened zones"; 6 - the assumed to be directions of the pleistocene-gologenovyx zones of fracture; 7 - the line of the equal amplitudes of relative uplift/rises (mm) in data of repeated leveling 1962-1966 (according to N. A. Koreshkov and A. E. Bayzman); 8. the pleysgoseystovaya region of earthquake 1966 (according to V. I. Ulomov); 9 - the sections of the possible seysmoprovavleniy; 10 - the slope of the pozdnepleystotsenovoy (golodnostepskoy) valley of

Chirchika; 11 - the boundary of city.

Depending on strike/course and the role in morfostrukture these "tectonic weakened zones" can be divided into three groups. The first group includes the elongated from northeast to south west linear zones, on which are laid valley N. Bozs and parallel by it finer beams the spirit of other inflows the Karakamysha. The northeastern continuation of the Bozsuyskoy zone which intermittent stretches itself through entire city, is expressed in relief by the laying of the upper inflows of Chauli and rnoy, detailed beam, which is open/disclosed into valley Salarav the region of the boundary of city. This the sole expressed in rl'yefe linear zone in the territory of city, which marks the assumed to be disruptive dislokatsii in is thicker than the sedimentary cover. It corresponds to the fracture, supposedly carried out V. A. Zakharevichem and A. I. Goncharenko on the basis of geological data from Kibraya to the park/fleet of conquest and further to south west, approximately to the western boundary of old city.

To the second group "tectonic weakened zones" are related the linear zones of meridional or the close to it direction in which on the south-vostochnom slope of the main Tashkent watershed of tale are laid the valleys of Salara, Chauli and Burdzhara, but to the third - elongated predominantly into storage the latitudinal direction of the zone of the ancient (pozdnepleystotsenovoy) fracture, which predetermined the laying of a whole series of parallel beams on its northwestern slope.

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The obvious geological proofs, which confirm the presence of the rzryvnykh disturbance/breakdowns in is thicker than the sedimentary cover along "tektonicheskicslablennykh zones" of the second and third groups, reveal/detected. However, by visual observations during Tashkent earthquake 1966 in the western part of the city, i.e., n the northwestern slope of the main Tashkent watershed, are revealed the systems of the cracks of latitudinal direction, proslezhivayushchiyesyas of west to the east in extent/elongation 10-12 km, primrnc along the zones of ancient fracture, established/installed in osnove geomorphological investigations.

During the comparison of the materials of geomorphological and geophysical investigations, is confirmed communication/connection of contemporary morfostruktury with the structure not only of sedimentary cover, but also paleozoic basement. Specifically, the linear morfostruktura of the main Tashkent watershed sufficiently corresponds precisely to the zone of the predominantly positive anomalies of the force, which stretches itself from northeast to south west, which N. B. Vol'fson and A. G. Khvalovskiy (1967) interpret as the large linear block/module/unit, limited by the fractures of northeastern strike/course. Local variations in the force gradient of gravity find the appropriate reflection in the bends of the longitudinal section of watershed, connected with the undulyatsiyami of its axis.

By special arbitrary symbols on map/chart (Fig. 136 are shown the

sections of golotsenovykh relative uplift/rises and depressions, isolated on the basis of the analysis of the special feature/peculiarities of the stroyeni of terraces in valleys and the manifestations of young erosive processes on watersheds. Judging by a change in altitude of golodnostepskoy and alayskoy terrass in valleys and large beams, the relative amplitude of golotsenovykh strains does not exceed the limits of several meters. The majority of the sections of golotsenovykh uplift/rises is timed to the axial parts of the positive morfostruktur, and depressions - to the axes of posletashkentskikh downwarp/troughs. At the same time the outlines of the individual sections, which tested obvious uplift/rise in holocene, do not coincide with the position of the isolines of the peak-to-peak amplitude of posletashkentskikh strains. One of such sections is arranged during the western termination of the Kal'kauzskogo watershed, the second - on the main Tashkent watershed, on south periphery of one of the stable local uplift/rises (in the region of astronomical observatory and seysmostantsii "Tashkent"). Apparently, their position objectively reflects the process of developing the corresponding morfostruktur in holocene, i.e., their gradual increase to the side of the periklirali of the basic uplift/rises.

Assigns attention position Chaulinskiy and Burdkarskoy "tectonic weakened zones" on stroyeniyu on the cell/elements of the plicate structure of the main Tashkent watershed. They are arrange/located in the flat tektonichkikh sols which divide local kulisoobraznyatiya, and, beginning at western wing of one of the uplift/rises, they

intersect it at acute angle and pass along the eastern wing of opposite uplift/rise.

It is characteristic that within the limits of the tectonic col, which divides two echelon-like uplift/rises in the center of city and by the occupied valley of Chauli, are localized the epicenters of the basic jerk/impulse and majority of the aftershocks of Tashkent earthquake 1966 and that into its outlines very accurately is inscribed the relatively short and narrow transverse band of a sign change of the lapse of the force, which is interpreted by N. B. Vol'fson and A. G. Khavalovskiy (1967) as section of the zone of eastern-almalykskoge overthrust. To other tectonic cols, which complicate the morfostrukturu of the main Tashkent watershed, correspond the determined changes in the force gradient of gravity. Apparently, this agreement is not random. The Formaniye of local echelon-like uplift/rises and dividing them tectonic cols, obviously, is connected with the special feature/peculiarities of the razviiya of basement. In the form of the increased activity of the tektonicheskikhsedlovin to which are timed "tectonic weakened zones", they are considered as their kind the "structural node/units", in each of which can arise seysmoyemrye voltage/stresses, and are separate/liberated as sections of the possible seysmoproyavleniy or earthquake-hazard zones.

~~end section.~~

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Character and amplitude of young tectonic motions.

The constructions, used during the composition of the schematic map/chart of young strains (Fig. 136), it is natural, they make it possible to directly determine neither the overall amplitude of the uplift/rise of the earth's surface in the region of Tashkent with respect to the level on which it was located at the end of the srednechetvertichnoge time nor amplitude of the relative uplift/rise of the main Tashkent watershed (axis of Tashkent uplift/rise) above the axial part of the Chirchikskoy depression. The first of these values can be established/installed only during full/total/complete regional analysis, the second is estimated according to the indirect sign/criteria, which include both geomorphological and geological data. Taking into account the contemporary excess of the surface of the Tashkent plain above the river-bed of Chirchika, the power/thickness abayskikh, golodnostepskikh and Tashkent is pebble, that make depression, and the depth of the bottom of the deposits of

Tashkert complex, it is pcssible, apparently, with a sufficient degree cf prctability to consider its apprcpriate 30-60 m.

The amplitudes cf local plicate defcrmatsiy within the limits of watersbed plain can be determined with much larger accuracy, whereupcn degree cf accuracy, obvicusly, it depends cn the intensity of the pcsletashkentskoy denudaticn treatment cf primary accumulative surface. Or strictly watersbed sectiens this accuracy is apprcximately equal to the accuracy cf ccnductirg hcrizontals at schematic mcrfcstrukturncy map/chart, i.e., -5 m. On the periphery of watersheds and especially within the sectiens cf the depressicns, which tested the ercsive effect cf the placed in them water flows, this the tochnost'chevidnc, is ccnsiderably lelcw. For conditicnal zerc tc kartprinyata the line, ckcnturvayushchaya tc the mcrfcstrukturu of the main Tashkent watersbed. The lines of equal strains (Fig. 136) are carried cut with interval 5 m by height, i.e., in acccrdance with the degree cf accuracy cf their estimaticn on watersheds.

As a whole for pozdnechetvertichnoye time - holocene, the depression of the tectonic dcwnwarp/troughs, which surround the mcrfcstrukturu of the main Tashkent watersbed, relative to conditicnal zerc it ccmprised: for a Tashkent dcwnwarp/trcugh - about 10 m, a Kelesskoy depression - 10-15, a Karakamyshskcgc dcwnwarp/trcugh - abcut 20 m. The depressicn cf the Bozsuyskcgc and Dzhararykskcgc dcwnwarp/troughs, which ccmplicate the rcrthwestern slope of

watershed, reaches 10 m. On the most main Tashkent watershed are separate/liberated three local uplift/rises 10-15 m amplitude. The greatest relative uplift/rise in the territory of city tested the northern section of the morfostruktury of Salar-Chirchikskogo watershed - its amplitude 20-25 m.

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Thus, the maximum amplitude of relative strain for an entire territory of city is 40-45 m, and for the morfostruktury of the main Tashkent watershed and its surrounding downwarp/troughs, it is 30-35 m. The amplitudes of the uplift/rises, which correspond to the morfostrukturam of Kal'kauzskogo and Bozsu-Karakamyshskogo watersheds, are comparatively small - less than 5 m relative to conditional zero, which it seems is connected with their position during the being immersed wing of the morfostruktury of the main Tashkent watershed. The average value of the gradient of relative strains during the wings of structures varies from 5 to 7 m/km, reaching only by places 10 m/km. Along the axes of positive structures (on the undulyatsiyakh of folds) the value of the gradient of relative deformatsiy does not exceed 2-3 m/km.

Accepting in the first approximation, that from time of the completion of the formation of the primary accumulative surface proluvial'nykh is loess Tashkent complex pass from 50 to 100 thousand summers, it is possible to calculate the average speeds of relative

vertical motions and their gradients. The maximum average speed of relative polnyatiya for the territory of city is equal to 0.5-1.0 mm/year, and for the most raised sections of the main Tashkent watershed with respect to adjacent downwarp/troughs - 0.3-0.7 mm/year. The maximum values of the gradient of the average speed in this case turn out to be equal to 0.1-0.2 mm/year.

During the comparison of data, which characterize pozdnechetvertichnye and golotsenovye strains in the territory of city, with the materials of the repeated leveling, carried out in Tashkent during the years 1962-1965 and in 1966 is noted very close connection and obvious heredity between young and contemporary tectonic motions.

The maximum of contemporary uplift/rise (40 mm) is located near seysmostantsii "Tashkent", within the outline, which corresponds on the map/chart of young strains to the section of the relative golotsenovogo uplift/rise, arrange/located on the periklinali of stable posletashkentskogo uplift/rise. Isoline 30-millimetric contemporary uplift/rise contours this section on its periphery. Isolines 20- and 10-millimetric amplitudes do not reveal/detect so distinct a communication/connection of young and contemporary motions, then the isoline of conditional zero very it is clear, although somewhat roughly contours the downwarp/troughs of the latitudinal section of the valley of Karakamysha and lower current of Salara (in the region of textile combine).

According to data of repeated leveling, the intense vertical mctions of the earth's crust in Tashkent are timed to time of earthquake. In the previous years local mctions tc the territories of city, which flcw/lasted against the backgrcund cf the ccmmcn/general/total uplift/rise cf the regicn cf Tashkent with respect to the region of Arysi (130 km the ncrth cf Tashkent), cf tale are insignificant and did nct intrcduce the perceptible changes intc the pcsitior cf leveling sigrs ir Tashlente to the period of the time, passed between two earthquakes (1868 and 1966 ~~kg~~), then the maximum average speed cf relative strain will prcncurce equal to 0.4 mm/year, but the maximum gradient cf the average speed will pronounce 0.2 mm/gcd•km. These values are ccmparable with the maximum average speed cf the vertical motions in late pleiocere - holccene and its gradient which tale are established/installed by gecmcrphclogical analysis.

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Being based on data cf repeated leveling cr the nonuniformity cf ccntemprcrary vertical mctions nct only in space, but also in time, historical evidence about repeated powerful earthquakes on the territory of Tashkent, cr geclcgical materials, it is possible tc assume that the young tectcnic mctions alsc had a character cf separate/individual momentum/impulse/pulses and their maximum intensity, obviously, ccincided in time with the periods cf powerful seismic jerk/impulses.

Thus, it is possible to make the following conclusions.

1. In spite of the considerable distortion of the contemporary relief of city by the anthropogenic and antropogennoobuslovlennymi processes, in its structure sufficiently fully were preserved the special feature/peculiarities, giving possibility to reveal/detect/expose and to evaluate character and intensity of young tectonic strains and to restore/reduce the history of the formation of its basic cell/elements.

2. The hereditary from early stages nectektogeneza obshiy character of the development of the tectonic structure of sedimentary cover is retained and at present. The hereditary structural plan/layout for territory, which is characterized by the predominant northeastern direction of the folds of sedimentary cover, is complicated by the development of the superimposed structures of latitudinal and sublatitudinal strike/course.

3. The important special feature/peculiarity of the formation of linear folds it represents the development of local echelon-like polnyatiy and dividing them flat tectonic ols, distinctly expressed in the contemporary structure of the main Tashkent watershed.

4. Along the plicated strains in morfostrukture, are outlined the linear disturbance/breakdowns of disruptive character - the

tectonic weakened zones whose development is caused by the voltage/stresses, which appear in thicker than the sedimentary cover in the process of the formation of its predominantly plicated structure. The echelon-like location of the local uplift/rises, which restrict tectonic cols, can be considered as sign/criterion of left shift/shears on the timed toward these cols tectonic weakened zones of shmeridional'nogo direction.

5. The strains of sedimentary cover in contemporary relief are the reflection of the tectonic processes, which take place in the tolshe of paleozoic basement. The development of these processes has continuous-intermittent character. The most intense strains of basement cause powerful seismic jerk/impulses, and, being transferred through the thickness of sedimentary cover, they give rise to the formation of local uplift/rises and depressions and linear zones of fracture on the surface of the Earth.

6. The seismic activity of the territory of city is caused by the common/general/total high tectonic activity, connected with the continuous retraction of foothill downwarp/trough (Tashkent-golodnostepskoi basin/depression) into the common/general/total uplift/rise of the Alpine orogen of Western Tien Shan (Ryzhkov, Ibragimov, Yur'yev, 1961). As a result of this of process occur the common/general/total uplift/rise the plains and postupatel'noe the development of the linear structures, which lie on the periklinali of mountain ranges. The rearrangement of local structures, vyvannaya by

the expansion of uplift/rises, obviously, is accompanied by the reanimation old and by the laying of new fractures in thicker than the paleozoic basement.

7. By the materials of geomorphological analysis are confirmed the representations about the activity of the urdulyatsiy of the joints of linear structures - the tectonic ools, which correspond to the peregibam of the axes of the folds of sedimentary cover, as a result of which we consider them as most probable earthquake-hazard zones. [1]

FOOTNOTE [1]. With the origin/hearths of a deep laying folds in sedimentary cover cannot serve as the reliable indicator of seismic danger. - editor's note. ENDFOOTNOTE.

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Comparative analysis of Morfostrukturnykh special feature/peculiarities and deep structure of the chosen in the territory of Tashkent earthquake-hazard zones revealed, that most active of them is the pleystoseystovaya region of Tashkent earthquake 1966, which corresponds the most complex construction of section the basement also of sedimentary cover.

RESULTS OF VISUAL-AERIAL OBSERVATIONS OF THE REGION OF TASHKENT EARTHQUAKE.

By the author of this section are made visual-aerial observations of the city by Tashkent and adjacent regions [1] for determining natural and tectonic conditions aerotoges"yemkcy.

FOOTNOTE [1]. The group of the sent on mission colleagues comprised: V. E. Komarov - the director of laboratory, V. P. Miroshnichenko - stage scientific colleague and V. I. Markevich - the stage of irzhensr. ENDFOOTNOTE.

In this case were studied the geological-geomorphological conditions and the special feature/peculiarity of the manifestations of the earthquake both in the pleystoseystvoy region in the limits of city and in the territory of the adjacent part of the foothill plain. Special attention is devoted to research on communication/connections of the different manifestations of earthquake with the fractures, which intersect as it is assumed to be, the territory of Tashkent.

Flights above the region of earthquake were accomplished on the helicopter mi.-of I uzbek control GVF [ГВФ - Civil Air Fleet] during two day - 26 and on 27 May 1966. Observations were conducted from height from 50 to 400 m. Tales are made the following routes: the airport of Sergeli with outcrop into the region of the merging/coalescence of the ditchhes of Karakamysh and Bozsu and then upward on zryku to Bozsu before its intersection with the channel of Aktepa. Along the channel of Aktepa, the route is continued to the

region of Kazhgarki, which is located in the epicentral zone of earthquake. Then, to northeast along the upper current of ditch to Bozsu, on the ditch of Salar and the channel of Salargres and Bozsu again into the center section of Tashkert (region of Kazhgarki), and from it - to the north-north-west to of pos. Saryagach for the tracking of the possible manifestations of earthquake in the direction of tashkentskiy - Almalykskiy fractures. Herce route is again laid into the center section of the gocda with the subsequent return through the region of station to the airport of Sergeli.

On 27 May all the indicated routes of tale are repeated for checking observational data on 26 May; in this case bygone made two off-fields landing, is additionally travelled route on ditch to Bozsu from the place of the inflow in it of the channel of Aktepa to the northern part of the region of Kazhgarki.

Indicated (basic), and also some supplementary routes covered the territory, which covers city distric and the considerable part of the adjacent to it foothill plain.

The Tashkent earthquake on 26 April 1966 was revealed in the zone of the transition between the mountainous region of North Western Tien Shan (spine/ridges the Karzhantau, Ugamskiy, Pskemskiy, Chatkal'skiy) and the eastern edge of Britashkentskoy basin/depression, complicated by the newest folds of North Western Tier Shan.

On the foothill plain among the rivers of Chirchik and Keles, is

fixed not less than two sections, for fizikko-geographical conditions of which says considerable effect the development of the buried plicated structure of spine/ridge to Karzhartau. One of such sections is the region g. Tashkent, by others - the region of Iski-Tashkent. It is indisputable, they are connected with the places of the active development of the mentioned structure, which can be one of the factors, which complicate the seysmotektonicheskuyu situation in region.

Fig. 137. Diagram of the newest tectonics of the foothill plain of south-west Tien Shan on the section of the subsidence of folding khr. to Karzhantau. He composed V. P. Mirosnichenko according to data of visual-aerial observations, 1966. 1 - the common/general/total outlines of Tashkent uplift/rise; 2 - rechnaya grid/network.

There is also an assumption that it is perpendicular to the fold-disruptive zone of northeastern strike/course, through the territory of city, it passes the Tashkent-almalykskiy fracture of northwestern strike/course. Under territory the cities, on are given the uzbek geophysicists, are revealed/detected the discontinuities of the paleozoic basement and other directions. In this case, it is assumed that the Pritashkentskaya fold-disruptive zone and Tashkent-almalykskiy fracture intersect under the territory of Tashkent, which increases potentially the seismic danger of region.

During the execution of visual-aerial observations, were considered the special feature/peculiarities of seysmotektonicheskoy situation pointed out above. Special interest in this case it represented the establishment of the manifestations of earthquake, caused disruptive and to skladchatymi by the cell/elements of the complex anticlinal structure of the south-west subsidence of spine/ridge Karzhantau. Within the limits of foothill plain, the anticline is immersed and on topographic surface is geomorphologically barely expressed. This, of course, impedes the determination of its role as seysmogennogo factor.

Visual-aerial investigations consisted of the attempt to find (by analogy with some other, geologically enclosed territories) the indirect sign/criteria of the manifestation of the buried Karzhantauskoy structure in the landscapes of foothill plain, since it was assumed that in the form of the considerable activity in Tien Shan of the newest and contemporary tectonics and gradual involvement of

Tashkent-golodnostepskoi depression in orogenic mode/conditions" (Byzhkov, Ibragimov, etc., 1962), the manifestations of the submerged folds of spine/ridge to Karzhantau they can be reveal/detected on the surface of plain.

After the first visual-aerial routes, which were being accompanied by the morphological analysis of topographic maps, it is bygone established/installed that important indicator in the which interests us relation are the numerous cell/elements of hydrographic grid/network. So, the rivers of Chirchik and Keles delineate within the limits of foothill plain its part with the morphological sign/criteria, distinctly caused by geological structure (Fig. 137). Here along plain it passes the weakly expressed watershed between these rivers, as very flat northwestern and abrupt/steeper and shorter southeasterly by slopes. With a comparatively pryamilneynoy valley r. Chirchik the podnozh'ya of the opposite sklona of watershed has r. Keles describes the well expressed in plan/layout arc. The same configurations and of r. Kurukkeles, arranje/located is somewhat western. The line of common/general/total bend of Chirchik-Kelesskogo, on the whole asymmetric watershed passes through the territory of Tashkent and then is somewhat western than Iski-Tashkent. In its extent/elorgation ir loess deposits of Tashkent complex, are observed the active manifestations of erosion, as a result of deflation considerably are clarified serozennye soils, developed on loess loams, and in the region of pos. Trommel among loess loams on watershed in a series of the places of onaruzheny

Paleogene deposits.

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Joint newest the anticlines of spine/ridge to Karzhantau is immersed in south-west direction. In connection with this the surface of plain from g. of Chirchika to pos. The Russian Chinaz of Syrdar'i descends almost on 500 m. Here by the river-beds of Chirchika. Kelesa and Syrdari sufficiently clearly is contoured south-west periklinal' Karzhantauskoy anticlines.

Thus, the Keles-Chirchikskiy watershed corresponds to subsidence Karzhantauskoy anticlines and is the indicator of place and direction of its passage. Judging by the given sign/criteria, anticline has and here south-west strike/course and noticeable asymmetry. Since the indicated features of its morphology are reflected in the structure of loess deposits, it is possible to consider that the thickness of these deposits is enveloped by the newest and contemporary tectonic motions, connected with the last/latter stages of the razvtiya of the structure of spine/ridge Karzhantau.

In rabone g. of Tashkent, the section of subsidence anticlines in the directions of the mentioned visual-aerial routes is bygone is investigated in more detail. For this, was carried out also the morphological analysis of the topographic and other special map/charts. The observations of tale are extremely hinder/hampered by

the very large degree of dislocation of the natural landscapes of foothill plain. All the same in this territory are reveal/detected the sign/criteria, which indicate the existence here relative to the large uplift/rise, which separates against the background of the common/general/total subsidence of the plicated structure of spine/ridge Karzhantau to south west.

Most distinctly uplift/rise is expressed by the cell/elements of hydrography - by the rivers of Chirchik and Keles, and also by numerous ditchhes. So, the ditchhes of Zakh and Ashi, which curved flow around the region of Tashkent from northwest, reveal/detect here the outline of the northwestern wing of the uplift/rise, forming the appropriate slope of Chirchik-Kelesskogo watershed. In this same place and the river-bed g. of Chirchik describes to friend, but it considerably more smoothly is directed to opposite side. The general layout of the mentioned cell/elements of natural and artificial drainage system contours asymmetric brachyarticlinal structure with abrupt/steep and short southeasterly, flat and long northwestern by wings, complex on its ob'yemu to structure (Fig. 138). The size/dimensions of this structure are very considerable: on the cross section, passing through Tashkent, its width reaches 25, and on extent/elongation 45 km.

By the cell/elements of hydrography is separate/liberated well also the crest part of the uplift/rise, in limits of which is arranged by g. Tashkent. So, ditchhes Bozsu and Salar, beginning from

urochisha barrow they diverge to different sides, flowing the crest part of the uplift/rise. This especially one can see well, if we bear in mind the river-bed of the old current of ditch to Bozsu in the northeastern part of the city. In its time by the activity of man it bygone is considerably deflected to the south for a water supply central, more elevated, part of the city. So, flowing uplift/rise, is deflected to the south ditch the Karasu, arrange/located below, during its southeasterly wing, but almost accurately repeating the common/general/total configurations of the ditch of Salar. With the visual-aerial tracking of the river-beds of these ditchhes, it is bygone noticed that they pulled by population nearer to the upper part of the city. Old river-beds, now deserted, filled up and built on can be seen from air on a series of the sign/criteria, connected with the effect of the relics of these river-beds on the contemporary appearance of city.

From the northern and northwestern sides of city, the development of uplift/rise monitors the position of the ditch of Karakamysh, which sharply changes here its current from south-west to latitudinal, and then to meridional direction.

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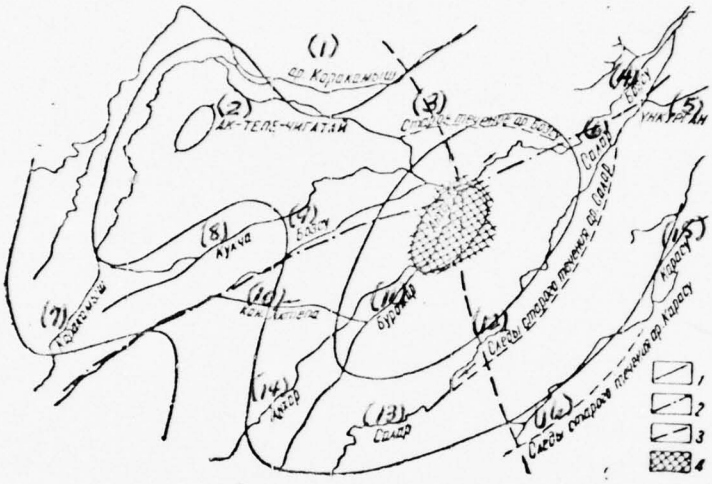

Фиг. 138.

Fig. 138. Diagram of the newest tectonics of the region of Tashkent earthquake during April 1966. He composed V. P. Mirochnichenko according to data of visual-aerial observations, 1966. 1 - the common/general/total outlines of Tashkent uplift/rise; 2 - Karzhantauskiy fracture; 3 - Tashkent-almalykskiy fracture; 4 - epicentral zone.

Key: (1). the arc. of Karakomysh. (2). Ak-chepe-CIGATAY. (3). Storov current is arc. to Bozsu. (4) to Bozsu. (5). Unkurgan. (6). Solar. (7). Karakatysh. (8). Kukcha. (9). To Bozsu. (10). Kahn. Aktepa. (11). Burdzhar. (12). Traces of old current the arc. of salor. (13). Solar. (14). Arkhor. (15) to Karasu. (16). Traces of the starogo of current arc. to karasu.

By this and by a series other ditchhes here distinctly delineated one additional independently expressed uplift/rise, crest part of which is located in the region of Aktepa - Chigatay. From Tashkent uplift/rise it is separate/liberated by the col in which rspolozhena are the western outskirts of city.

Ditchhes Bozsu, Ankhor, Burdzhar are cut into at depth 25-30 m into the tolshu of loess deposits at the territory of the center section of the city and intersect the crest and prisvodovuyu parts of the uplift/rise. These vrezy in depth are considerably less than part of the territory, adjacent to uplift/rise. [1]. IN3 FOOTNOTE [1]. The depth of vreza can serve as the indicator of vertical motions, if be confidence in the fact that all other factors are taken into account and their effect is elimirated. For the territory of Tashkent this not entirely thus. - editor's note. ENDFOOTNOTE.

Promising according to some sign/criteria, the crest part of the Tashkert uplift/rise experienced considerable primary breakdown, but its constant leveling by population for the erection of structures and formation/education of land noticeably lowered the results of the activity of exogenous processes. From air by places it is noticeable that fine construction, osbenno in the old part of the city, just as in region Kazhgarki,vytyagivayutsya on the lines of the previous watersheds between the ovraami mary of which to nastoyashchemu time turned out to be those which were filled up. On some sections of this part of the city, are still visible the traces of radial (relative to the arch/summary of uplift/rises) vrezov. Deciphering

krupnomasshatabnykh aerial photographs will make it possible perhaps sufficiently full to reveal/detect/expose these relics of the natural situation, which existed in the territory of city before its mass population. ; however, even, in the special feature/peculiarities of the contemporary building-up of the territory are visible some regularities, caused by the presence of uplift/rise. So, the common/general/total outlines of the building-up of city are elongated in severoposточnom direction, according to the strike/course of its arch/summary, the long ulivy, for example, of the Shota of Rustavelli, Ergels, Pushkin and Lunacharskoye highway, are laid along axis uplift/rises [2].

FOOTNOTE [2]. City built itself, prisposobливayas' to the special feature/peculiarities of relief, but not nectectonics. Thus, communication/connection of the plan/laycut for streets with nectectonics is the idea, idushaya too far - editor's note. ENDFOOTNOTE.

Configuration izoseyst in essence it is subordinated to the outlines of the crest part of the uplift/rise.

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In the boundaries of city, it is especially nearer to epicenter, on the abrupt/steep or abrupt slopes of ditchhes Bozsu, Ankhor, the Burdzhar, common/general/total direction of which it coincides with

the strike/course of the Pritashkentskoy (Karzhantauskoy) fold-disruptive zone of tale are noticed fine sufficiently numerous fresh taluses. At the same time after city even with the very attentive inspection of their slopes both from the helicopter and during off-fields landing fresh taluses and collapse were not observed.

Of many ditchhes (for example to Bozsu) slopes very abrupt/steep, frequently vertical or have reverse gradients (in the places of the washing of abrupt slopes). On these slopes frequently are observed the unstable large stolbochraznye forms of wind erosion. Underground tolchik in no way were reflected in their morphological appearance. This says in otom that in the direction of Karzhantauskogo fracture, where above it or near it are arranged the mentioned ditchhes, not the bygone noticeably expressed shifts [1].

FOOTNOTE [1]. Collapse appear not only in the zone of the shifts of bedrocks, but also in the zone of the jolts, caused by earthquake - editor's note. ENDFOOTNOTE.

To north- and to south west from Tashkenga along direction to Bozsu, and also the ditchhes of Salar, Khasanbek, Kunqrad, etc. also is not bygone the zemecheno of the collapse of slopes.

In Tashkent-almalykskom fracture, in the band of the ditchhes of Karakamysh, Khasanbay, Zakh, etc. and the village of Saryagach, valley r. Keles the noticeably expressed destruction structures or

strain in soil is not also reveal/detected. The same it is possible to say and on those sections of this fracture which lie/rest to the south from Tashkent.

Hence it follows that if the earthquake is connected with shifts or the indicated zones of discontinuities, then only in the center section of the city. Such sections are the separate/individual component/links of the buried plicated structure of spine/ridge to Karzhantau.

If we bear in mind the structure of the analogous regions where similar structure is well revealed by denudation, then possible sufficiently confidently to conduct certain analogy with the Caspian lowland of Turkmenii, within limits of which occurs the subsidence of the folding of Kopet-Daga (Fig. 139). Many of these discontinuities do not exceed the limits of fold, but are developed in direction its crest parts. This it indicates communication/connection of their formation/education with the active development of fold. Analogous phenomenon can be, also, near region g. of Tashkent.

The observations conducted and the considerations outlined above have, of course, preliminary character, they can be refined after the laboratory and field deshifrirovani of the materials of the planned aerodotos"yemki.

According to the technical project, comprised by the author

together with V. B. Komarov and V. and Markevichem, it is expedient to fulfill:

1) the large-scale aerial photography of the epicentral region of earthquake, which covers crest part of the Tashkent uplift/rise. Optimum here can be scales 1:50.000 and 1:12.000 with which on aerial photographs will be depicted the fine detli of landscape and building-up of city;

2) the aerial photography of scales 1:20.000, 1:40.000 I 1:730.000, by which must be enveloped the considerable territory, which involves completely Tashkent uplift/rise, the complex of the young deposits yeenizmennoy part, the outcrops of basic ancient rock/species on the slopes of the which surround mountain ranges the Karzhantau, Ugamskoge and Chatkal'skoge, the different cell/elements of the morphology of the landscape of foothill plain.

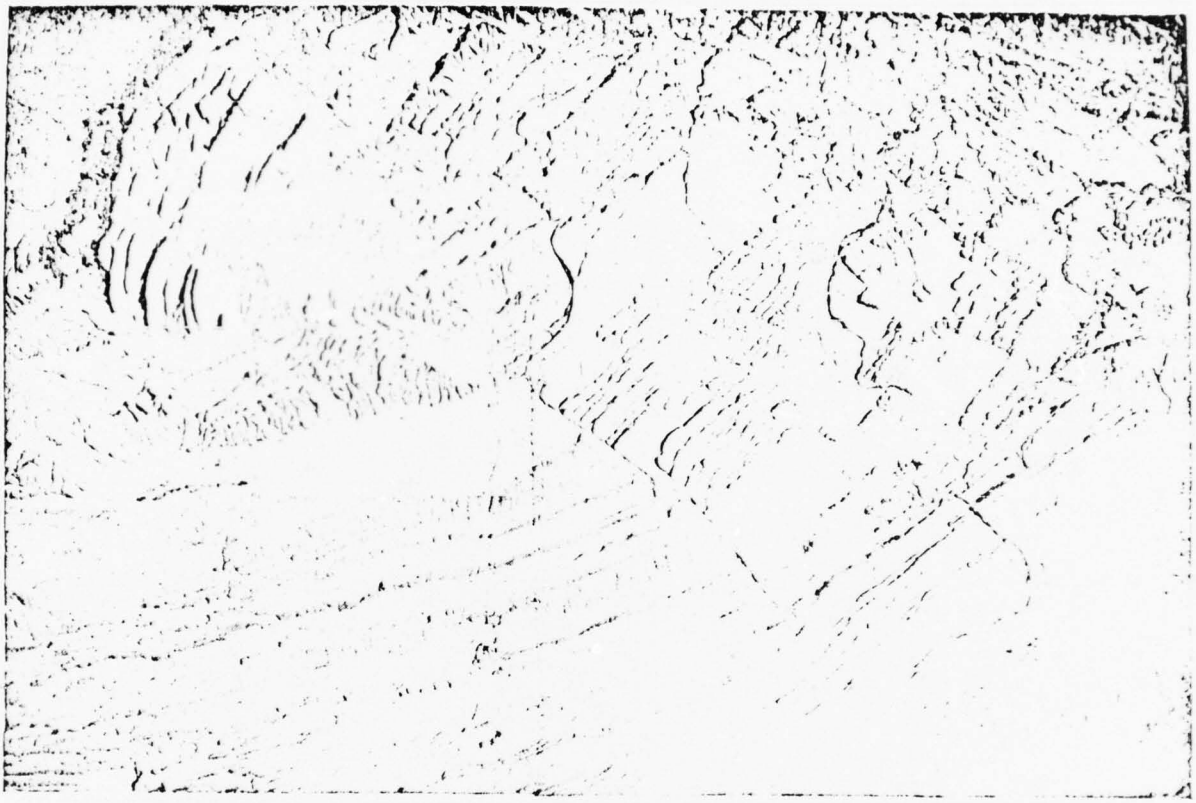

Fig. 139. Disruptive complicated-block structure on the section of the energetic uplift/rise illegible anticlines, composed by verkhnetretichnymi and quaternary rock/species (Is Zatsadnaya Turkmeniya).

By aerial photography must be covered the area, elongated on foothill plain across valley r. Chirchik to the western slopes of Chatkal'skogo spine/ridge.

The better time of the execution of aerial photography is the first half of spring or autumn when meteorological conditions contribute to obtaining the aerial photographs of a good contrast and, therefore, large informational capacitance/capacity.

Use of materials of the planned aerial photography together with data of seismological and geophysical studies will make possible minutely to study the local and regional manifestations of the newest motions, including seysmotektonicheskogo value.

In conclusion one should say that the contemporary aerial photography of the territories, encompass by earthquakes, can give very precise on quality and enormous by volume informatsiyu./V the case of Tashkent earthquake as in many other analogous examples, the execution of aerial photography strongly late. To time of its production of the consequence of earthquake, the tales are already largely eliminated, many destroyed houses are dismantle/selected, etc. It seems to us that for aerial survey fixation of the consequences of earthquakes must be created such state positions, which would make it possible to reveal in these cases the maximum of effectiveness and to obtain the materials of aerial photography

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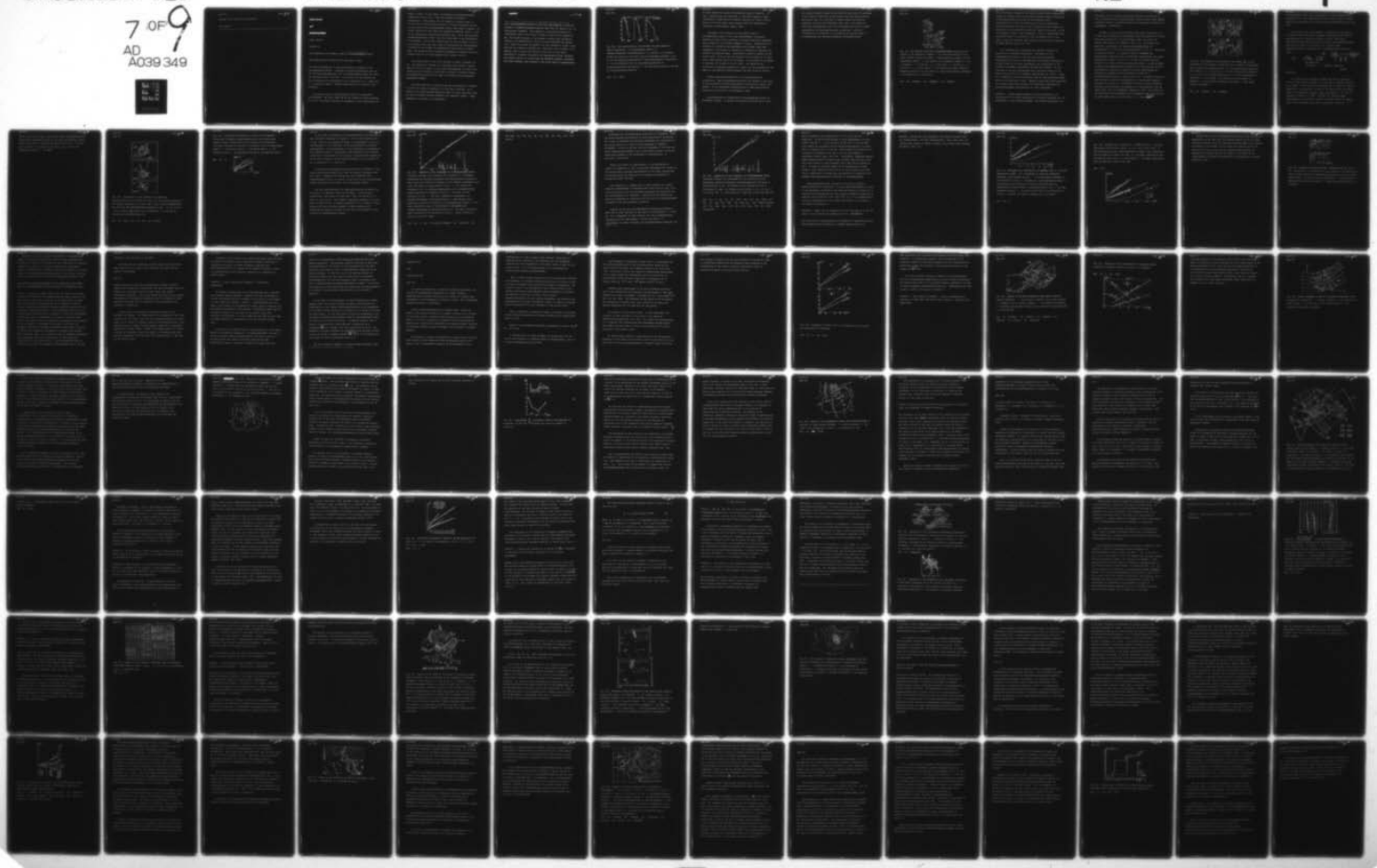

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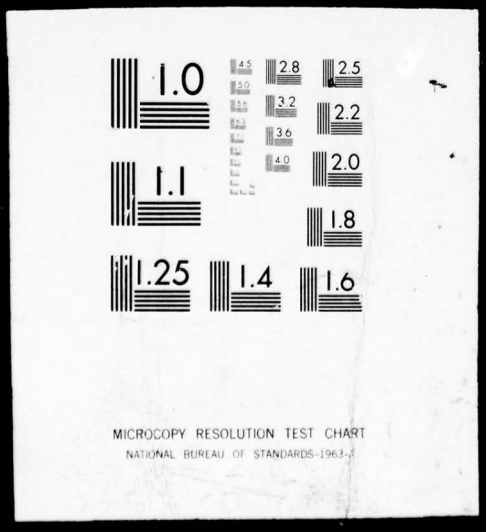

already to 3-4 days after catastrophe.

end section.

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Pages 303-339.

Chapter VI.

DEEP STRUCTURE OF THE EARTH'S CRUST IN ~~A PRITASHKENTSKOM~~ the near-Tashkent REGION.

HIGH-SPEED/VELOCITY CUT/SECTION OF THE EARTH'S CRUST.

The first approximation of high-speed/velocity cut/section for a Pritashkentskogo region. Hodograph and high-speed/velocity time cut (in the first approximation,) for a Pritashkentskogo region the tales are constructed into 1957-1962. The procedure and the results for this construction are published by Ye. M. Butovskoy et al. (1962) and a. I. Zakharovoy (1962). Briefly these results are reduced to the following.

The earth's crust in Pritashkentskom region is represented three-layered. The first layer has on the average by region thickness 0.5 km and the average velocity of propagation of the longitudinal (P)

waves 2-3 km/s - in the region of developing of mezokaynozoyskogo complex and 4.2-4.5 km/s - near the outcrops of paleozoic rock/species. Rock/species with the speeds of P-waves, equal to 4.2-4.5 cm/s we conditionally related to low-speed Paleozoic period. On some sections of Pritashkentskogo region, this layer is absent. Of course, speech here goes about two completely different layers - I and I', the executed by rock/species different ages. We to them ascribed common/general/total index I only for convenience in the calculations of hodographs. During such calculations the role of layers I and II as low-speed, that cover the region of localization of origin/hearths, is reduced to the conduct of insignificant corrections in transit time. The values of these corrections depending on whether do have we a matter from 1' or 1" are changed within limits 0.1-0.2 s.

The second layer it has on the average by region thickness 7-8 km. The velocity of P-waves in it increases from roofing to bottom from 5.5-5.6 to 5.8 km/s. In the first approximation, the law of the increase of the velocity in this layer is bygone is accepted linear. On contemporary treatment this layer is identified with metamorphic paleocyskim complex.

The third layer has a tol'inu 34 km, and the velocity of P-waves is from 6.0-6.1 km/s of roofing to 6.7-6.8 km/s of bottom. If we adhere to the usual "granite-basaltic" model of crust, then this layer one should consider totality "granite" and "basaltic" layers. These Nazavaniya, of course, are conditional.

Thus, during the construction of high-speed/velocity cut/section for a Pritashkentskogo region in the first approximation, we did not succeed in separate/liberating granite layer from the basaltic i.e. to find Conrad's boundary. Mohc surface at the boundary velocity of longitudinal waves 7.8-7.9 km/s is found on depth on the average 42 km. The regular increase of the apparent velocity with epicentral distance Δ for Mohorovicic's wave it is reveal/detected not bygone, i.e., within the limits of studied by us the interval of values Δ this wave can be accepted as glowing log. Physically this it means, it is obvious, that if within the limits of the first 5-10 km under Mchorovicic's boundary the velocity of seysmichesikh waves increases with depth, then so it is slow that the kinematic effects, connected with this increase, they lie/rest at the error limits of observations.

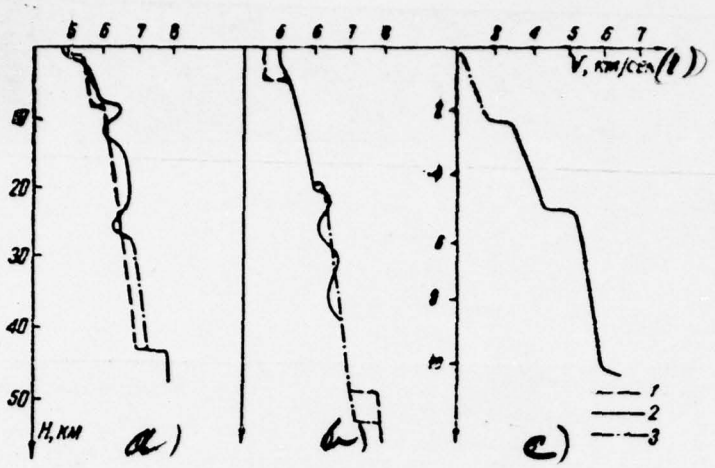


Fig. 140. High-speed/velocity cut/sections for some regions of eastern uzbekistan. a) Pritashkentsiy region; b). Chatkalo-fergaiskiy block/module/unit; c) territory g. of Tashkent (within the limits of the first 10 km of topographic surface); y-2-e or y-e the approach/approximation of high-speed/velocity cut/section; 2 - 2-e or electronic unit the approach/approximation of high-speed/velocity cut/section; 3 - the uncertain sections of the 2nd or 3rd approach/approximation.

Key: (1). km/s.

At large depths must appear the noticeable lapse of velocity. On this, testifies the fact that with Δ = 450-500 km branch P, which corresponds to Mohorovicic's boundary, displaces by branch P with a velocity of 8.4-8.7 km/s, which clearly bears the impression of refraction (Is Butovskaya, Ulomov, 1962).

The model of the structure of the earth's crust in Pritashkentskom region in the first approximation, is created according to data of the notations of powerful industrial explosions and is related to the mountain framing of region. Investigating the notations of explosions and earthquakes when seismic waves were propagated in the region of transition to platform, we somewhat they modified the obtained model. Modification touched in essence of the second layer. We found that the velocity of its roofing is 5.6 km/s only in the mountain parts of the region. In the region of transition to platform, it is equal to 5.2-5.3 km/s. The values of the velocities of remaining boundaries in crust, and also thickness of the layer in this modified diagram remained the same as and in initial.

Further approach/approximations of high-speed/velocity cut/sections. These approach/approximations are reduced, on one hand, to the elaboration of high-speed/velocity cut/section in depth, with another - to the increasing differentiation of high-speed/velocity cut/sections on territory (Is Butovskaya, 1968).

High-speed/velocity cut/sections in Pritashkentskom region are exclusively complex. In moving from roofing to the bottom of crust,

are observed diverse changes in the velccity alcng with the increases of the values of velocity, by such rapid, that they can be equated with shcck, there are intervals cf smooth change with positive gradients, and also with waveguides (Fig. 140). The diagram of fcur-layer-heterogeneous crust can be accepted cnly as the roughest approximation of high-speed/velocity cut/sectien. Strikes a difference of the character cf a change in the vertical speed in Pritashkentskom and Chatkalo-Perganskcm block/mcdule/units.

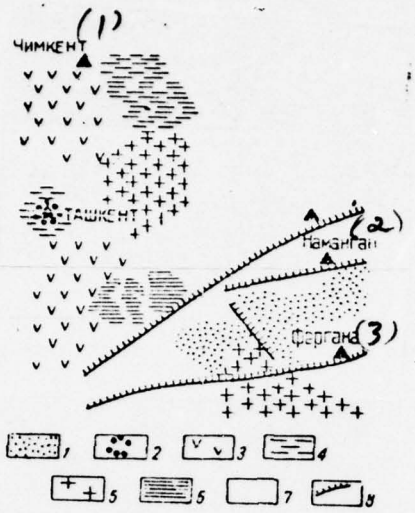


Fig. 141. The velocity field for a Pritashkentskogo region and its framing in the interval of depths h = 0-2 km of the surface of the Earth (300-400 m above sea level). Classification on speeds v of the longitudinal waves: 1 - the speed of the sedimentary complex v = 2.0 3.2 kmsek; 2 - v = 3.3-4.3; 3 - v = 4.4-4.9; 4 - v = 5.0-5.3; 5 - v = 5.4-5.8; 6 - v = 6.0-6.3 km/s; 7 - the sections for which could not determine value of v at this level; 8. some large tectonic fractures, on the dannm of V. A. Pak et al.

Key: (1). Chimkent. (2). Namangan. (3). Fargana.

If in the latter a change of the vertical speed occurs comparatively slowly and smoothly, then in the first structures finely stratified, in high-speed/velocity cut/section are observed shocks. Simultaneously is noted the shattering of crust in plan/layout. High-speed/velocity spectrum of the rock/species, which compose the upper part of the cut/section within the limits of the first 5-10 km of topographic surface, very variegated. Along a comparatively high and uniform field of velocities in the northwestern part of the region, there are sections, where velocity field bears the character of mosaic pattern (Figs. 141, 142).

High-speed/velocity cut/section for Tashkent according to observations of powerful aftershocks. Hodographs for the Pritashkentskogo region of tale are used during coordinate determination of the main jerk/impulse of the Tashkent earthquake on 26 April 1966 and its first aftershocks from observations at the stations of regional grid/network and gave fair results. So, the epicenter of the main jerk/impulse with probability 90o/o hit the small circle 1.5-2.0 km in diameter (Abutaliyev, etc., 1967). Hence it is possible to draw the conclusion that the same hodographs remain valid in the territory of city. However, during their application/use to processing data urban stations was reveal/detect/exposeed the full/total/complete groundlessness of these hodographs [1].

FOOTNOTE [1]. During special research on the coordinates of the origin/hearth of the main jerk/impulse of Tashkent earthquake and its aftershocks, is used another approach: the refined coordinates are

calculated, on the strength of high-speed/velocity cut/section in city, the based on data seysmokarctazha, seismic surveys (KMPV [KMRB correlation method of refracted waves]) and seismology (regitrtsii of earthquakes). ENDFOCTNOTE.

In fact, if the notch of stations, most close to epicenter (Δ = 1-3 km), gave satisfactory intersections, that the notches of the more moved away stations (Δ = 5-8 km and more) gave, as a rule, the transfer the greater, the greater Δ (Fig. 143). We selected the hodograph, corresponding to smallest permissible depth of origin/hearth h = 2 km, and they assumed that $K = V_p/V_s = 2$. The spread of notches is great. an increase in depth h usudshaet the intersection of notches, but, as showed the constructions, the formal umen'sheiye of depth of up to h = 0 it does not improve position. Increase K to 3 only a little decreases the spread. it was necessary to change high-speed/velocity cut/section for the territory of city - substantial to decrease the velocity in layer under sedimentary thickness as compared with the velocities, common for a Pritashkentskogo region as a whole (Fig. 143). In order to determine this velocity in the first approximation, we constructed compound hodograph for a region g. of Tashkent from data of many earthquakes and many stations without the separation of origin/hearths from the depths (Fig. 144), not exceeding, apparently, 7 km. The velocity in the beginning of this hodograph, and consequently also layer velocity at small depths turns out to be small, V = 3.3-4.0 km/s.

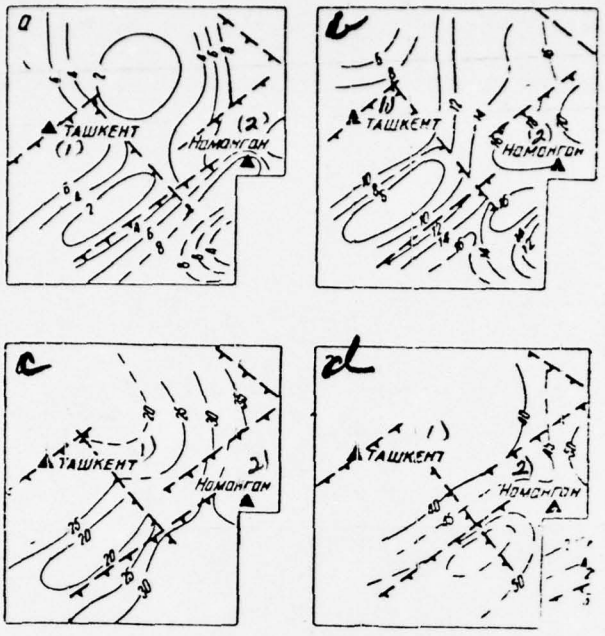


Fig. 142. The diagram of the isolines of the depths (km) of the occurrence of the surfaces on which velocity v (km/s) of longitudinal waves reaches the determined value for a Pritashkentskogo region and its framing. a) v = 5.6-5.8; b) v = 6.0-6.2 (rocfing of "granite"); c) v = 6.7-6.8 (is krovaya "basalt"); d) v = 7.8-7.9 (Mohorovicic's boundary); I - the isoline of the depths of the occurrence of surfaces, 2 - the uncertain sections of isclines; 3 - some large tectonic fractures.

Key: (1). Tashkent. (2). Namangan.

Of this godcrafa found first approximaticn of high-speed/velocity cut/section for a city (cut/section we do not give, since it differs little from cut/section in the second approach/approximation; see Fig. 140).

For checking first approximaticn, we additicnally used data on the powerful explosicns which concerned origin/hearths and station, arrange/located in immediate proximity of city. These data, unfortunately very scarce, possess the special feature/peculiarities, which are not placed in the scope of the concepts about high-speed/velocity cut/sectien for a Pritashkentskogo region as a whole.

1) Дата	2) Номер пункта регистрации	Δ, км	t, сек.	e° (угол выхода сейсмического луча) 3)
13. XI 1953 г.	1	11	2,1	37
	2	14,7	3.1	
02. II 1954 г.	3	17	3,7	
	4	20	4,4	39

1) Date (2) the number the point/item recording s. 3) (angle of departure seismic ray/beam).

It is easy to see according to these data that in interval Δ = 11-14.7 km the velocity composes 3.7 km/s, and in interval 17-20 km, is 4.2 km/s. At the velocity in precipitaticn 2.5 km/s, the angle of departure e° in point/item 1 attests to the fact that in the lowest pcint of the refracted ray/beam, which corresponds Δ = 11.7 km, the velocity is equal to 3.2 km/s. Assuming that directly under precipitation the velocity is equal to 3.4 km/s, and at the lowest pcint of the ray/beam, which came on epicentral distance Δ = 11 +

14.7/2 = 12.9 km, 3.7 km/s,, we we will obtain high-speed/velocity cut/section, sufficiently close to the first approximation, found, namely, the bottom of precipitation has velocity of V = 3.4 km/s, also, at depth 2.5 km under precipitation, i.e., 5 km of the topographic surface, V = 4.2 km/s.

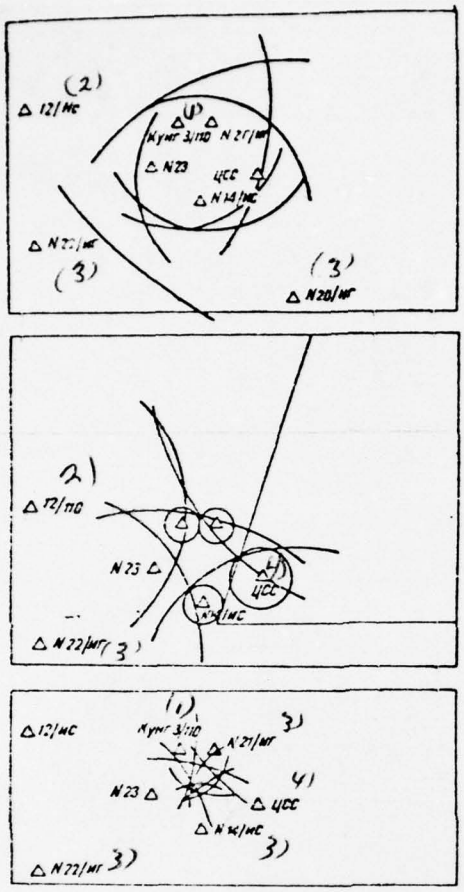
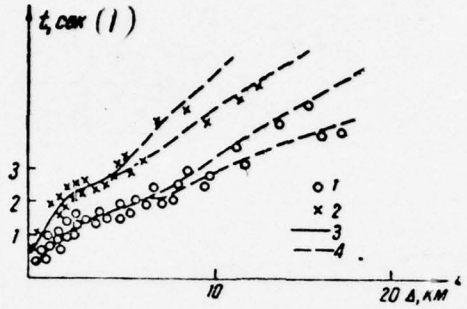


Fig. 143. Intersection of the notches of the stations, arrange/located in the territory of city, for the iterative impulse of the Tashkent earthquake on 29 June 1966 7 hours (time to poGrinvichu). When using by the Pritashkentskim hodograph of wave P_g. h = 2 km; v = 4.5-4.7 km/s; $K=\frac{v_p}{v_s}=2.0$ (a); by that hodograph - K = 3.0 (b); by hodograph for territorim city (c).

Key: (1). Kung. (2). ns. (3). ng. (4) QSS.

Fig. 144. Experimental hodcgraph on a series of the powerful aftershocks of Tashkent zamletryaseniya wher usirg these urban statiens without differentiation on h (depth of crigin/hearth). Coordinate determination prcduced cn hodcgraph fcr a Pritashkentskogo region. 1 - the travel time P; 2 - the travel time S; 3 - the averaging curve; 4 - the ambiguous secticns cf the averaging curve.

Key: (1). s.



On the first approximation of high-speed/velocity cut/section, we have calculated hodograph for depths h = 2-8 km with step/pitch Δh = 1-2 km. Using it and varying the depth of origin/hearth, we are the pereopredelili of the coordinate of the origin/hearths of Tashkent zamletryaseniy. The determination of the coordirates of epicenters in the different depths of origin/hearth, the selection of the optimum depths and the evaluation of the accuracy of solution were carried out on EVM [ЭВМ- computer] by the method, described in the articles of Ye. M. Butovskoy et al. (1967a, b).

In obtaining high-speed/velocity cut/section for Tashkent in the second approach/approximation, we used the ottained hodographs (see Fig. 140c). Comparing this cut/section with cut/section for a Pritashkentskogo region as a whole, we see that they are distinguished within the limits of the first 5 km of topographic surface.

The chief characteristics of high-speed/velocity cut/section in territory g. of Tashkent entail the following. Directly under precipitation (with speed are less than 3 km/s, the velocity of P-waves is 3.3-3.4 km/s. More deeply it smoothly grow/rises to 4.2-4.4 km/s, at depth 4.5 km, it sharply increases to 5.1-5.3 km/s, to those values which are encountered usually in layer directly under precipitation during the framing of city and on the majority of the sections of Pritashkentskogo region.

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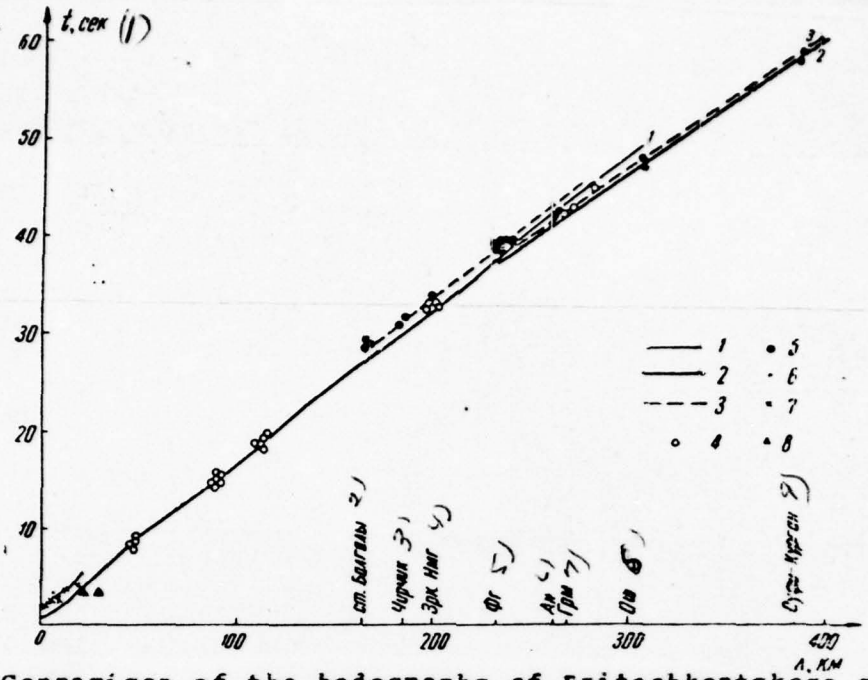

Fig. 145. Comparison of the hodographs of Pritashkentskogo region (including framing) with hodograph for a territory g. of Tashkent, Ferganskogo and Chatkalo-Ferganskogo block/module/units according to data of the most powerful aftershocks of the Tashkent earthquake on 26 April 1966 depth of origin/hearths 3-4 km. 1 - the theoretical hodograph of the 1st approach/approximation for a Pritashkentskogo region (including the framing of city); 2 - the same, for the territory of city; 3 - the same, averaged for Ferganskogo and Chatkalo-Ferganskogo block/module/units; 4 - experimental points according to data of the stations of Pritashkentskogo region; 5 - the same, according to data of the stations of Ferganskogo and Chatkalo-Ferganskogo block/module/units; 6-7 - the same, according to data of stations in the territory of city; 8 - these stations No 2 (KS3) of 8 and 13.VI 1966.

Key: (1). s. (2). the stage of Balgaly. (3). Chirchik. (4).

Zrk. Nmg. (5). Pg. (6). An. (7). GRM. (8). Osh. (9). Sufi Harrow.

Hcdographs for Pritashkentskogo region and g. of Tashkent. Using the second approach/approximation of high-speed/velocity cut/section for a city, we conducted one additional redefining the coordinates of the origin/hearths of a series of the aftershocks of Tashkent earthquake. In view of the fact that the hcdographs of the first and second approach/approximations for a city almost coincide, we did not obtain large changes in the coordinates of origin/hearths, in particular, their depth.

Knowing the depths of origin/hearths, it is interesting to conduct the comparison of the corresponding hodographs for a series of the zemltryaseniy, recorded simultaneously by the urban grid/network of stations and by the stations of the regional grid/network of Central Asia (Fig. 145.146).

From figures it is evident that at urban stations all transit times are overestimated in comparison with those that are tale, if on in the territory of city was retained Pritashkentsiy cut/section and the corresponding to it hcdograph. velocities in the territory of city are understated in comparison with velocities on Pritashkentskomu hcdograph at the same epicentral distances.

Figures 147 and 148 give experimental hcdographs according to data only of urban stations for the depth of origin/hearth H = 3 and 4 km. For a comparison in these figures, are shown pritashkentskiye hcdographs for the same depths h. We see that with $\Delta = 0$ disagreements in times on Tashkent and Pritashkentskomu hodographs are about 0.5 s.

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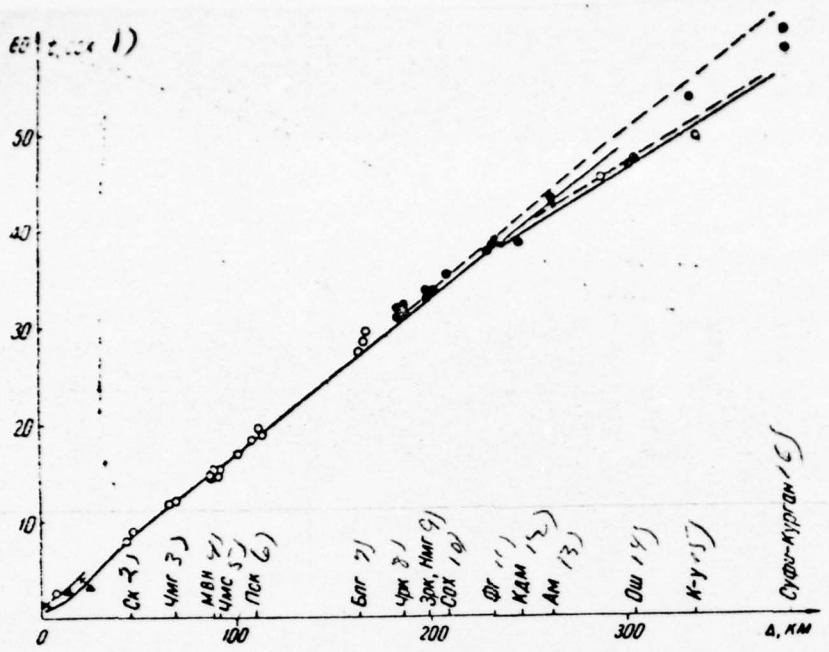


Fig. 146. Comparison of the hodographs of Tashkentskogo region (including framing) with hodographs for the territory of city, Ferganskogo iChatkalc-Ferganskogc block/module/units, the depth of origin/hearths 5-6 km. Tc stations in the territory of city it corresponds 21 points (in figure are not shcwn); 1, 2, 3, 4, 5, 6, 7 cm. in Fig. 145. 8. data stages No 2 (KS3) for 9 and 15/VI 1966 142.

Key: (1). s. (2). Sk. (3). Chmg. (4). MVN. (5). Chms. (6). PDR. (7). Bpg. (8). Chrk. (9). Zrk, Nmg. (10). Wooden ploughs. (11). Fg. (12). Kdm. (13). AM. (14). Csh. (15). Ku. (16). Sufi-barrow.

With an increase Δ they grow/rise to 1.5-2 s, then they are stabilized. On sufficiently greater Δ these disagreements the more lesser, the more h. In the territory of the city of the stations, which showed the systematic special feature/peculiarities of transit time it is bygone only 3 of the 60: this is bygone the station of 12 institutes of seismology, and also 1 and (in less measure) 6 party/batch "Earth" (Figs. 146, 147). Furthermore, pronounced special feature/peculiarities of transit times differed some stations, which were being located at large distances (20-22 km) from the center of city. In spite of the small number of the observations of these stations, their materials turned out to be cyen' vanymi, since they gave to vozmozhnot' to outline zone and character of transition from Tashkent high-speed/velocity cut/section to Pritashkentskomu.

Three-dimensional/space placement of the area of Tashkent high-speed/velocity cut/section. In very rough approximation the zone of the propagation of Tashkent type high-speed/velocity cut/section is contoured in plan/layout by the line, passing through the locations of stations 13/IS, 20/IG and 12/IS (Fig. 143), i.e., it is represented by circle of approximately 8 km in radius with center in the region of the garden of revolution [1].

FOOTNOTE [1]. Stage 1/IS is arranged in 6 km to the south of Np 23, the stage of 13/IS 10.5 km the northeast of No 14. ENDFOOTNOTE.

More accurately to restore/reduce the character of transition from one high-speed/velocity cut/section to another managed only on two

profiles: TDA and TVS with beginning in the region of garden (Fig. 143, submeridional - the TDA, sublatitudinal - TVS), ends A and C of profiles they exceed the limits of figure, cut/sections these profiles are shown in Fig. 146.

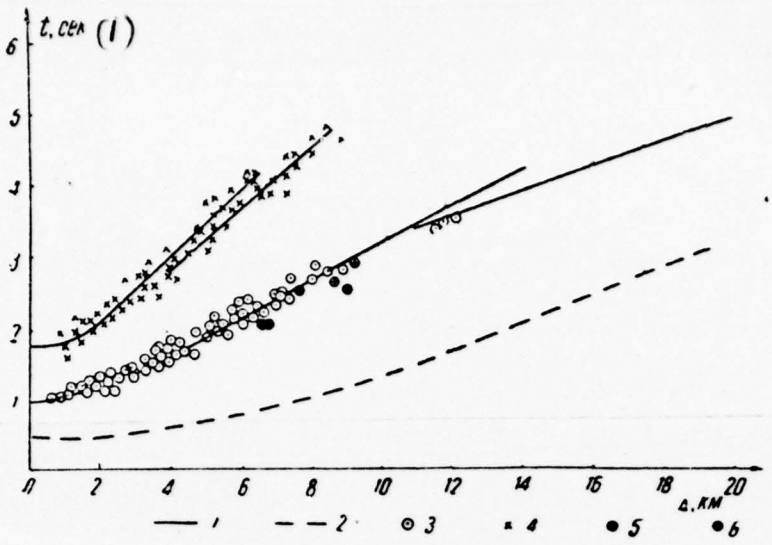
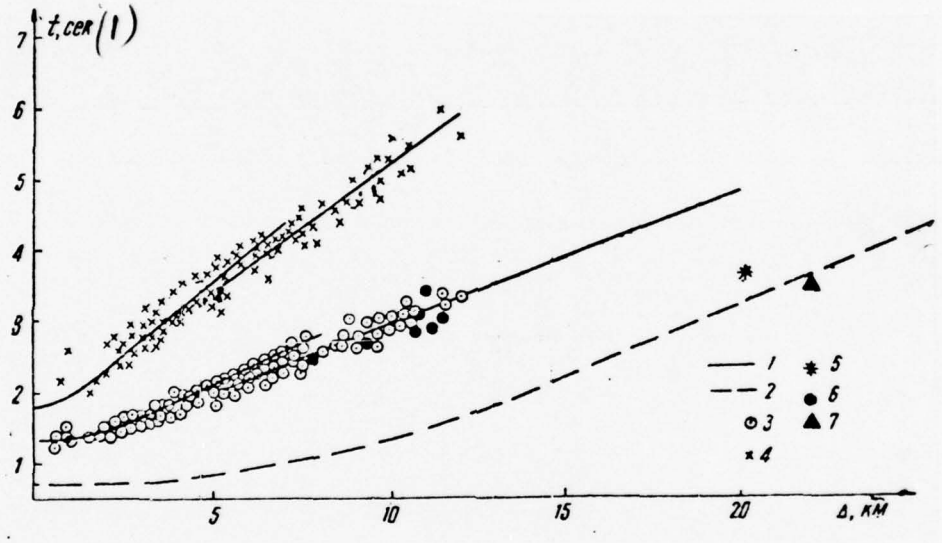


Fig. 147. Hodograph for a territory g. of Tashkent with h = 3 km with experimental points. for a comparison is given the theoretical hodograph of the framing of city. 1 - the theoretical hodograph of the territory of city; 2 - the same for a Pritashkentskogo region; 3 - experimental points according to data of urban stations, the characteristic transit times of longitudinal waves (P); 4 - the same, transverse waves S; 5 - the same for the waves of the Pstantsii of 12/IS; 6 - the same, for waves P, station No 1 and "Earth".

Key: (1). s.

Fig. 148. Hodograph for a territory g. Tashkent with h = 4 km with experimental points (conv. desig. 1, 2, 3, 4 cm. in Fig. 147). 5. the experimental points, which correspond to transit time according to data by stages No 2 (KS3) 8.VI 1966. 6. the same, according to data by stages No 12/IS and No 1 (" the Earth"); 7 - the same, according to data by stages No 2 (KS3) 13.VI 1966.

Key: (1) s.



Through data of the Pritashkentskoy expedition, which carried out observations on the same areas by equipment "Earth" and by the using procedure, different from that which was described above, are obtained the similar to our results in the relation to existence within the limits of the city of zone with the lowered/reduced velocity of propagation of seismic waves in the region of the depths of the origin/hearths of Tashkent earthquake and its aftershocks (is orange, Shumilina, 1968).

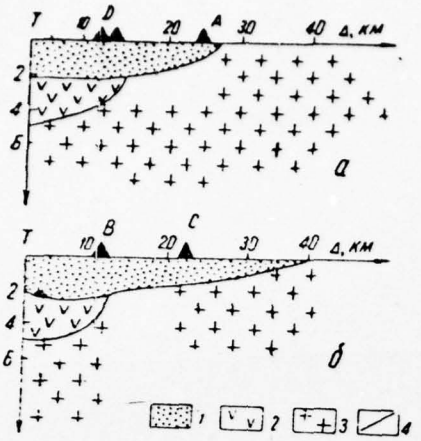


Fig. 149. Diagrams of transition from a cut/section of the type "A "to a cut/section of the type" b" on some profiles in the territory of city and region (bottom of precipitation according to data of seismic survey works). a) profile TVS; b) profile TDA; 1 - precipitation; 2 - nizkoskorodtnoy Paleczoic period; 3 - high-speed Paleozoic period; 4 - interface.

According to data of seismic survey KMEV, in Pritashkentskom region in a series of sections are found the same anomalously low velocities of P-waves in the roofing of the rock/species of paleozoic complex in the limits of the first kilometers from topographic surface. Aromalies bear character by the places isometric, by places linear the elongated connection/inclusions. In the latter case they reach in length 30 km and in width 6 km (Ergashev, Israilov, 1967).

SOME SPECIAL FEATURE/PECULIARITIES OF THE STRUCTURE OF THE EARTH'S CRUST IN A PRITAShKENTSKOM REGION ACCORDING TO SEISMOLOGICAL DATA.

It does not appear at present doubts, that the reason for tectonic phenomena lies itself in the complex processes, which proceed in the lower parts of the earth's crust and in the upper mantle of earth. Once in this stage of investigations, it is possible to outline certain communication/connection between geological structure and the structure of deep horizon/levels. The development/detection of this communication/connection makes it possible to obtain the supplementary information about the development of the earth's crust and upper mantle. so, carried out by us earlier the comparison of the character of the occurrence of interfaces in the earth's crust with the geological structure of Chatkalo-Kuraminskogo region made it possible to outline some correlation dependences of magmatic rock (Ulomov, 1966; Gor'kovoy, 1967). It is possible that the analogous dependences can be revealed, also, for a whole series of other structural cell/elements of the earth's crust. Such investigations only are conceived and require the abundance of the reliable data on the deep

structure of one territory or the other.

Most effective and relatively economic during the study of the deep structure of the earth's crust and earth as a whole are the methods of seismology.

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However despite the fact that the seismology is based on strict physical and mathematical regularities, her many conclusions about the structure of the earth's crust and upper mantle bear largely hypothetical character. Only in the exceptional cases can be obtained the sufficiently encouraging information about the presence of deep fractures, the nature and the character of deep interfaces, the structure of layers, etc.

On the nature of interfaces in the earth's crust and the procedure for studies. Our issledovaiya on the simulation of the "cut" interfaces in the earth's crust and the development/detection of their effect on the kinetic and dynamic special feature/peculiarities of the recorded with the surface of medium seismic waves also to any degree hypothetical (Ulomov, 1966). However, the concepts about the "mosaic" structure of interfaces unlike the concepts of lamellar medium with the sharp boundaries of section have more substantiation, in any case for the earth's crust.

According to the accepted by us working hypothesis about the deep structure of the earth's crust, "granite" thickness, especially in geosynclinal regions, is broken by numerous fractures into block/module/units and is pierced by the magmatic intrusions, which are characterized by the "basaltic" velocities of propagation of elastic waves [1].

FOOTNOTE [1]. Terms "granite" and "basaltic" - conditional.
ENDFOOTNOTE.

The dynamic kharakteritiki of the kvazigolovnoy wave, connected with Conrad's surface ("granite - basalt"), and also the absence of routine reflections from this boundary do not testify to the presence of clear transition "granite - bazal't'. Growth/build-up with the depth of the velocity of propagation of elastic waves in "granite" and the relative potoyanstvo of the velocity in "basaltic" layers make it possible to present the lower part of the earth's crust more monolithic and "elastic". On this, speaks the fact that the base mass of seismic centers is concentrated in the most "brittle" granite layer.

The bottom of the earth's crust is characterized by a more abrupt change in the physical properties. As already mentioned, the used at present procedure allows, although indirect the pute, to ptiyti to assumption about the "mosaic" and block structures of deep horizon/levels makes it possible to obtain the concept about the

relief of the thicknesses, which possess approximately identical physical properties. Specifically, relief we will bear in mind with the presentation of the results of the investigations of the deep structure of the earth's crust in Pritashkentskom region and as its crucible framing. In this case, we do not deny the presence of block/module/units, but vice versa we leave after the geologist-tectonophysicists the full/total/complete right to extrapolate the zones of tektonichesikh disturbance/breakdowns at depth. In our view this operation is especially legal for regions with the high gradients of a change in the deep relief (specifically, in the region of Tashkent).

As the basis of investigations, is placed develop by us earlier (Ulomov, 1966) the method of seismic anomalies, which entails the determination of the special feature/peculiarities of the propagation of the seismic waves, refracted on interfaces in the earth's crust and the upper mantle. In this case, were utilized the seismograms of the stationary and expeditionary seismic stations, arrange/located within the limits of the studied territorii. Predominant majority (20) of stations is equipped with three-component installations from vibrographs VE-GIK in assembly with the galvanometers of GB-IV. The parameters of seismic receiver and galvanometer were selected in such a way as to ensure a constant increase (approx. 2000) in the interval of the periods of forced oscillations 0.05-1.0 s.

The basic volume of material is obtained during recording close earthquakes (epicentral distance to 700 km).

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For special observations of powerful industrial explosions, was created the supplementary grid/network of seismic stations. Explosions were conducted strictly at the signal of a precise time, transferred to the seismograms of station on radio. This considerably increased accuracy of observation.

Special feature/peculiarities of seismic waves. Within the limits of the studied territory, is isolated a series of the arrivals of the seismic waves, clearest of which turned out to be refracted waves P, P * and P^0, connected in accordance with the bottom of the earth's crust (Mohorovicic's boundary), the boundary between "granite" and "basaltic" layers (Conrad's boundary) and the surface of crystal basement.

The existing at present interpretation of waves P^0 and P does not cause doubts, and the selection of the seismological model of the earth's crust is determined in essence by the alternative of the

interpretation of wave P, which by the different researchers is explained by the reflection, the refraction or other processes, connected with the propagation of the elastic waves of waves in the earth's crust. We is interpreted wave P * as kvazigolovnuyu, connected with boundary granite-basalt".

Wave P * under actual conditions at by us the distances (200-700 km in question) is outlined secondly arrivals and, as a rule, it has the clear, pronounced form, which easily yields to correlation. The arrival of wave P * is accompanied by the prolonged "loop" of the complex oscillations whose amplitude often prevoskhoit in intensity the amplitude of the basic arrival. These special feature/peculiarities of wave picture, apparently, are caused by the interference of the waves of different origin, in essence of straight lines and reflected from both interfaces in the earth's crust.

Wave P, refracted by subcortical layer, is recorded in the range of the indicated distances as the first arrivals and is comparatively simple in form.

Range of the predominant oscillation frequencies in waves P and P* - 0.3-1.0 Hz.

To 180-200 km in the first arrivals, is recorded wave P°, and only in this interval it virtually yields to interpretation. Wave P° is more high-frequency (to 10-15 Hz).

The hodographs of longitudinal waves P and P *, constructed for the eastern mountain part of the Pritashkentskoye region and its western plains territory, have different angles of the slope (Fig. 150). The earth's crust of the system of Chatkal'skikh spine/ridges as as a whole winnow the southeasterly part of Central Asia, is characterized by the following velocities of propagation of the seismic waves: $V_p = 7.9$ km/s; $V_p^* = 6.4$ km/s and $V_p^c = 6.0$ km/s.

Somewhat great significance of the wave propagation velocity P and P * are obtained for the territory, arrange/located to west from Tashkent the profile of Dzhizak - Kulkuduk): $V_p = 8.2$ km/s and $V_p^* = 6.7$ km/s (see Fig. 140). The difference in the values of the velocities the propagation of seismic waves under conditions of eastern and Western uzbekistan does not have thus far explanation.

the structure of the earth's crust. Is most complicated the structure of deep interfaces in the region of the system of Chatkal'skikh spine/ridges (Fig. 151). As a result of investigations, it is revealed, that Chatkal'skaya and Kuraminskaya subzone sharply they differ from each other in terms of the structure of the basic interfaces in the earth's crust.

The Chatkal'skaya subzone is characterized by the considerable subsidence of the bottom of the earth's crust to depth 60-65 km of sea level and by the large power/thickness of "granite" layer (to 40 km).

The isclines of depths of up to both interfaces in the earth's crust of Chatkal'skoy subzone have the ellipscid form, elongated on the strike/course of the system of mining constructions, while in Kuraminskoy subzone is observed reverse picture.

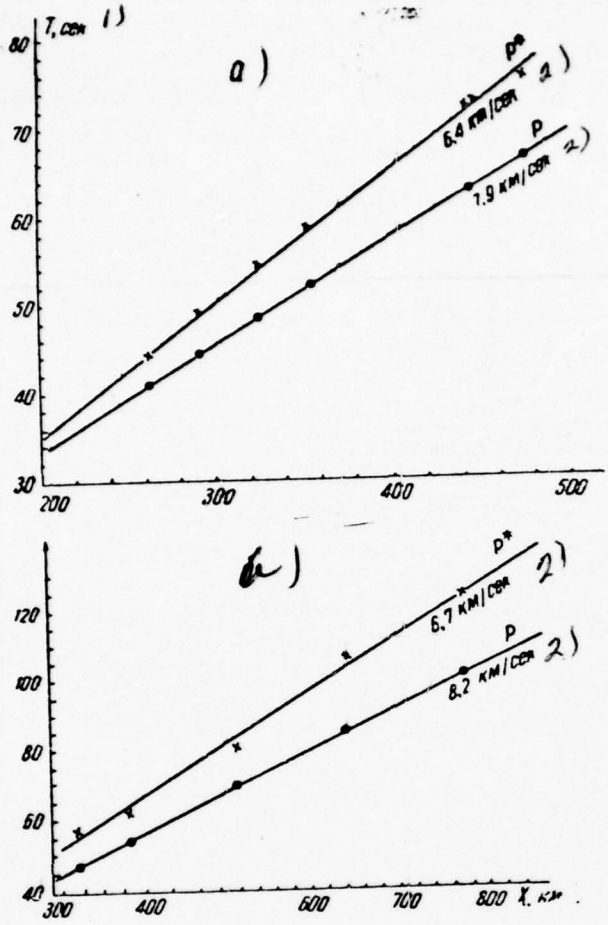


Fig. 150. Hodographs of waves P and P * the mountain (a) and plains (b) territories of uzbekistar.

Key: (1). s. (2). km/s.

Here anticlinal deep structures are expressed by flatter forms, than synclinal - in Chatkal'skoy subzone. The configuration of the isclines of depths in this region indicates the less "elasticity" of Kuraminskoy subzone with respect to its surrounding structures (see Chapter II, Part III).

The trace of intense strains is observed in the southeasterly part of the Kuraminskoy subzone where is noted the sharp thickening of the earth's crust from 40 to 50 km which answers, apparently, the zone of north-ferganskogo seysmoaktivnogo fracture. Approximately the same picture is noted in the region of Tashkent [1].

FOOTNOTE [1]. This analogy is doubtful. Places of thickening the isclines of relief Mokho much and in other regions. - editor's note. ENDFOOTNOTE.

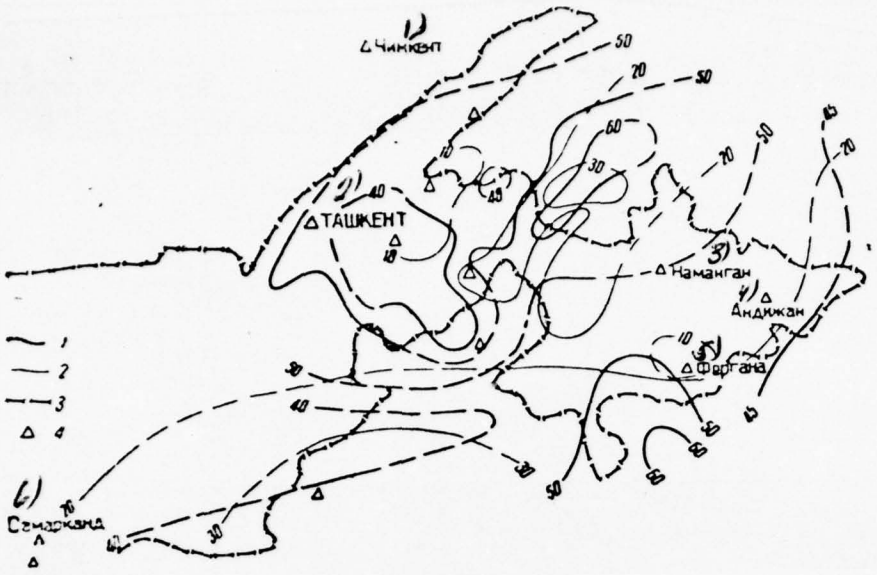
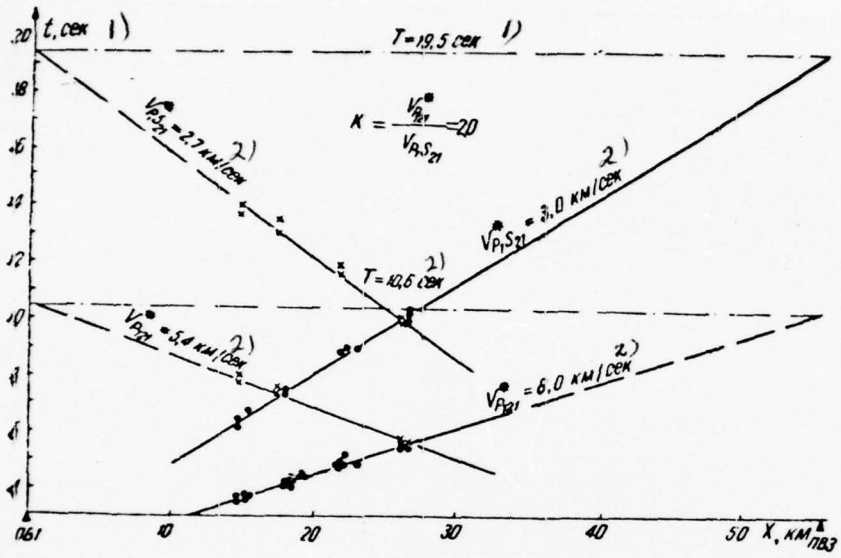


Fig. 151. Diagram of the deep structure of the earth's crust of eastern uzbekistan. 1 - the iscline of depths of up to Mohc surface; 2 - isodepth of up tc Conrad's surface; 3 - the boundary of republic; 4 - the staticnary seismic statiens of the institute of seismolcgy the an of the Uzb.SSR.

Key: (1). Chimkent. (2). Tashkent. (3). Namangan. (4). Andizhan. (5). Fergana. (6). Samarkand.

Fig. 152. Hodographs of the longitudinal and transverse waves, refracted by paleozcic basement in regicn g. of Tashkent.

Key: (1). s. (2). km/s.



A maximum increase in the thickness of the Earth's crust and granite layer in Chatkal'skoy subzone coincides with the complex region of the merging/coalescence of two large tectonic disturbance/breakdowns of the Talasskogo and north-ferganskogo fractures of respectively northeastern and south-west strike/courses. This region is known as most active in seismic relation. Specifically, here on 3 November 1946 occurred 9-10 scale-number earthquake, which caused jolts in Tashkent up to 7-8 balls intensity.

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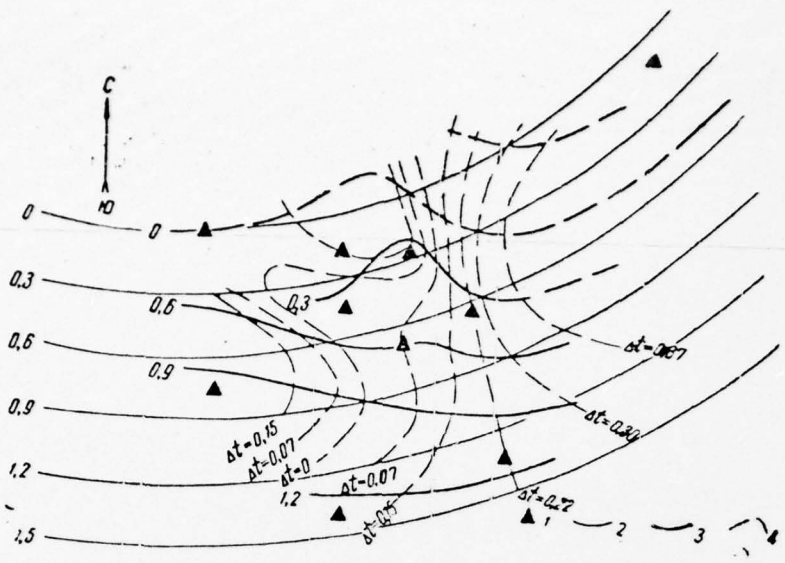

Fig. 153. Surface hodograph of wave P°, constructed according to the seismograms of explosions. 1 - seismic stations; 2 - the isochrone of normal field; 3 - the isochrone of the observed field; 4 - the isochrone of difference godstrafa.

It is direct under the territory of Tashkent the depth of the occurrence of the bottom of earth's crust on the order of 45 km, Conrad's boundary 15-20 km. To south west from Tashkent, the Moho surface smoothly is immersed in the form of the narrow anticlinal fold to which on surface corresponds the strike/course of spine/ridge to Karzhantau. In all likelihood, the basic interfaces in the earth's crust of the northern, western and south parts of the Pritashkentskogo region are the flat, deprived of noticeable deposits structures with the greatest subsidences to 50 km.

Investigations in the territory of Tashkent and its neighborhoods. In the period of observations of the Tashkent earthquake by the seysmometricheskimi stations, arrange/located within the limits of city and its neighborhoods, is recorded a large quantity of explosions, which were being carried out around city by the uzbek geophysical trust of the Ministry/department of geology of the Uzb.SSR. For a determination by the seismological methods of the special feature/peculiarities of the structure of the upper part of the earth's crust the region of epicenter it is selected several dozen seismograms with the notations of the most powerful explosions (3.5-6.(Vol. BB).

At the epicentral distances (15-40 km in question) as the first arrivals proodit wave P^0, refracted by paleozoic basement. Wave P^0 ($P_{1\,2\,1}$) with the predominant oscillation frequency 10-16 Hz very clearly is recorded by vertical seismographs. The following sufficiently intense arrival have is interpreted we as an exchange

wave of the type P_1S_2 or $P_1S_2P_1$. Almcst all without exception/elimination nctaticns of explcsicns are characterized by very nitensivnymi surface waves with prcncurced dispersed.

In connection with the absence of the jcining of the tcrque/mcments of explosicns to absclute time, "time in origin/hearth" was determined with the aid cf the curve/graphs Tc Vadati, alcng the axis of abscissas of which were plot/depcsited time differences of the arrival of wave P_{12} to each station and tc the rearest at the pcint/item of explosicn, but alcng the axis cf crdinates, were plct/deposited the corresponding differences in the exchange and lcngitudinal waves.

Page 317. [redacted] Fig. 154. Isohypses of the roofing of crystal basement within the limits of the territory of Tashkent. 1 - seismic stations; 2 - isohypse with the indication of depth (m) from the surface of the Earth, accepted as horizontal plane; 3 - the zone of localization of the epicenters of the iterative impulses of Tashkent earthquake; 4 - the boundary of city.

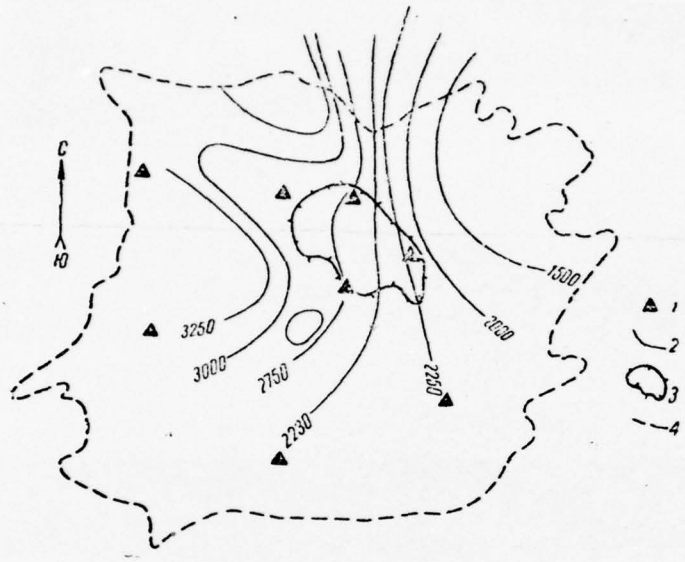

Figure 152 gives the ccntrary hodographs of the longitudinal and exchange PS-waves. Both that and other branch of hodograph they are connected well in izaimnykh points (±0.1 s). The difference in the apparent high-speed/velocity contrary hodographs as a whole is caused by the subsidence of the surface of crystal basement in northwestern direction. The relatively high accuracy of seismological observations (high scanning speed of seismograms and the accuracy of time service) allowed us to construct the map/charts of the isochrones of wave P0 (Fig. 153).

It is not excluded, but it can be even the more probably that wave P0 is connected not directly with the roofing of paleozoic basement, but it will bear the information about the integral structure of certain thickness into which it is included and granite layer. Between the fact, construction of the relief of the refracting boundary and its joining on depth and roofing of paleozoic basement gives the results, well khoglasuyushchiyesya with data of deep boring.

Figure 154 shows the map/chart of isohypses, constructed according to wave P0 from the series of the explosions, produced in just one place in the northwestern neighborhood of Tashkent.

The smallest depth of the occurrence of plicated paleozoic basement is fixed in the northeastern part of the city (1400-1500 m). Then, being step-like developed, interface already on the opposite outskirts of Tashkent reaches depth on the order of 3500 m. Intense downwarp/trough is observed in the north-north-western part of the

city, isolated of the western by the flat anticlinal curvature of surface.

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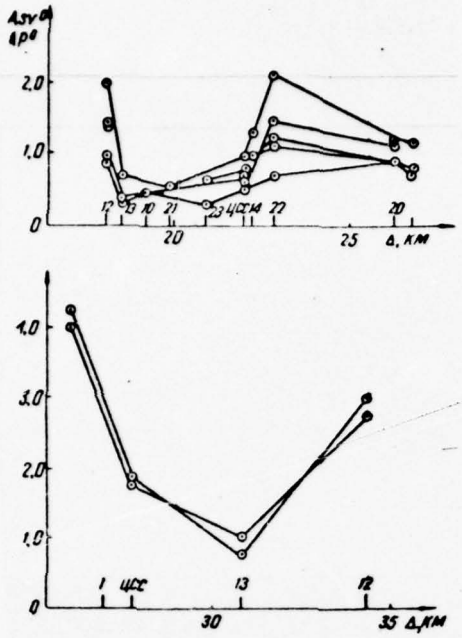

Fig. 155. Curve/graphs $\frac{A_S^0}{A_P^0}$ according tc data cf the notations of explcsicns (on the axis cf abscissas are shcwn the numbers of stations).

With its strike/course ccincides the tasic zcne cf localization of the epicenter of the aftershocks of the Tashkent earthquake, which, as the tasic jerk/impulse, turned cut to be those which were timed tc the tand of the greatest gradients of the relief of northwestern strike/course, which will agree alsc with the character of shift in the origin/hearth, determined by A. V. Vvederskcy's method (chapter II, Part I).

We have made the attempt tc reveal/detect/expose the physical heterogeneity cf focus zcne by dynamic calculaticns and constructions. Assuming that the tectonic disrupted region must to a certain degree attenuate/weaken the intensity cf the passinç thrcugh it waves and keeping in mind the possible distortion cf the amplitude of displacement due to the difference under grcund conditions (Mirzaev, Ulcmov, Zakharov, Ibragimov, 1969), we examined relative values $\frac{A_{sv}}{A_{p^0}}$.

The dependences of the relation of the amplitudes of vertically pclarized transverse waves SV, fcrmed frcm cf the longitudinal as a result of exchange in the region explcsicns and longitudinal refracted waves P^0, recorded by urban seismic stations, are characterized by sufficiently stable picture during repeated explcsions (Fig. 155).

Fig. 156 demonstrates the routes of the arrival of seismic waves at station of 5 point/items cf the explcsicns, arrange/located around city. The lengths of the cuts cf dctted lines are proportional to value $\frac{A}{A_{p^0}}$. As a result of the analysis cf dynamic wave picture, established/installed that in western and scuth-west regions the

crystal basement is complex by the more consolidated rock/species, than in the central and northeastern parts of the city. A most significant amplitude reduction of transverse waves is noted along the band of sharp jump/drop in the relief of plicated paleozoic basement, coinciding with strike/course focus zone of Tashkent earthquake.

Thus, after studying the deep structure of the earth's crust of Pritashkentskogo region and its mountain framing, it is possible to speak about the sl'ncy differentiation of the structure of Chatkal'skoy and Kuraminskcy subzones. The boundary of the essentially different structure of the earth's crust in mountain part is arranged approximately on one latitude with Tashkent and stretches itself then to the north city towards g. Chimkent. The structure of crust is direct in region g. Tashkent more spokopnoye, although here is observed the flat structure in the bottom of the earth's crust of the type of the anticlinal downwarp/trough, accordingly which slopes with the superincumbent thickness.

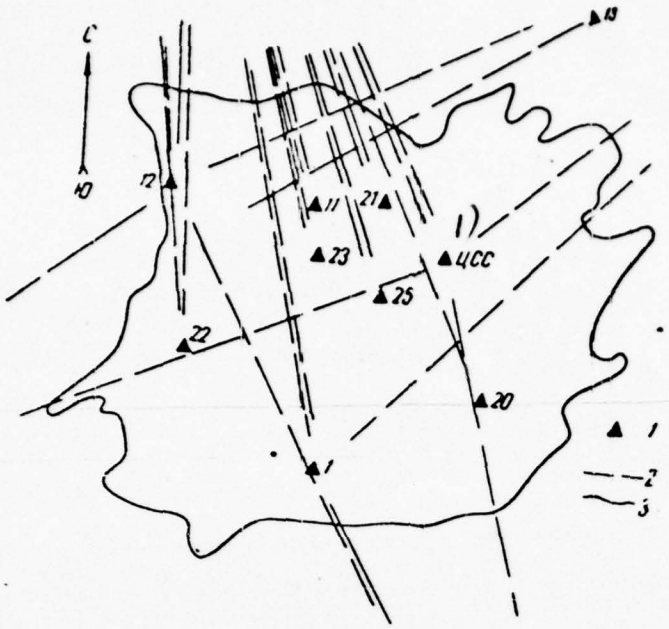

Fig. 156. Routes of the propagation of waves from the point/items of explosion to urban seismic stations. 1 - seismic stations; 2 - the route of the propagation of waves; 3 - the boundary of city.

Key: (1). ~~[illegible]~~ Ts SS

The discovered by us arcmalcus zone in plicated basement under the center section of the city hardly cne should consider as ccnsequence of the fragmentation of rock/species during Tashkent earthquake. In all likelihccd, its existence is caused by the presence here of diverse rocks and by the intensity of tectonic mctions in this regicn in the past.

Results of study by staticns "Earth" of the structure of the earth's crust and aftershocks of Tashkent earthquake.

The explanatien of the deep structure of any territory can be realized with the aid of KMPV [КМПВ - correlation method cf refracted waves], GSZ [МСЗ - deep seismic scunding] and staticns and stations "Earth". The applicatien/use of the first twc methods within the limits cf industrial city is virtually impossible due to the high background of the man-made interference cf the same frequency, as the waves, recorded with KMPV and GSZ (Mozzhenko, 1957). Unityvaya this, cn the proposition of M. K. Polshkcv and V. V. Fedyrskiy (Ministry/department cf geology cf the USSR), M. A. Sadovskogc and Ye. F. Savarenskogc (AS USSR), Kh. T. Tulyaganova, V. N. Gar'kovts, E. E. Fulley Block-Tal6-Virskogo and A. Kh. Khvalcvskogo (Ministry/department of geology cf the Uzb.SSR), is solved tc conduct deep research on territory g. cf Tashkert and its seismicity with the aid cf stations "Earth" (Mczzhenkc, 1961).

Wcrks with staticns "Earth" in Tashkent were carried out frcm 16 June through 22 December by 1966 Pritashkertskcy geophysical

expedition of the Uzbeskogc geophysical trust of the Ministry/department of geolcgy of the Uzb.SSR tcgether with VNIIGecfizinoy the Ministry/departments of geolcgy of the USSR.

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In them, besides the authors, took part V. N. Danilin, A. N. Mczzhenko, F. S. Eidelman, A. V. Suvilcva, I. I. Kagalova, E. V. of Isanina, etc.

Equipment "Earth". Prccedure for cbservaticns. Works were realized with the aid of 13 staticns cf notaticr "Earth" (Mczzhenko, 1961).

During the arrangement of the staticns cf rctation "Earth" in Tashkert were combined the cell/elements of profile and foul language cbservation systems. The profile staticns were arrange/located alcng the directicns, perpendicular tc the prcstiraiyu of two zones of the basic regional fractures: Tashkent and Almalykskoy, isolated according to data of aeromagnetic photcgraphing (Vol'fson, Khvalovskiy). At these staticns must the tales be obtained the deep cut/sections of the earth's crust in line SZ and YuV directions.

five - six stations during entire cperating cycle of tale are established/installed frcm area in the center cf city that, that they surrounded frcm all sides the fccus zcne of Tashkent earthquake (Fig.

157).

The basic goal of observations at these stations of notation entailed obtaining in immediate proximity to the origin/hearths of the notations of waves P and S, making it possible more or less to uniquely determine in space the location of these origin/hearths. For the stratigraphic joining of the boundaries of the exchange of crust three stations of the notation of istanovili next to three deep bore-holes, which revealed paleozoic basement, five stations - with profiles KMPV of past summers (see Fig. 152).

For the comparison of the notations of stations "Earth" with the notations of standard seismological station "Tashkent", and also explanations of the question concerning a comparative uchvstvitel'nosti of these stations one station of notation "Earth" arranged at seismic station "Tashkent".

The distances between the stations of notation "Earth" according to profiles varied from 500 m to 1-2, rarely 3-5 km, and the center of city - from 500 m to 1.5 km. Entire from 16 June through 22 December within limits g. of Tashkent it is mastered 5 arrangements according to 13 by stations of notation.

The duration of the works of the stations of notation with separate/individual arrangements changed from 15 to 20 days. With passage from one stand to another from three to five stations, they

remained on the spot for the correlation correcting/fitting of obtained data (Orange, 1967).

The notation of elastic waves with the stations of notation was realized 24-hour with the aid of seysmorafcv VEGIK (f = 1 Hz) which were establish/installed on four to each station. two seismograph of tale vertical Z_1-Z_2, two - horizontal, X, Y. The planes of vibration of the coils of seismographs were oriented in the direction of S-~~W~~-X; Z-V-U.

To the displacement of the housing of seismograph upward, to the north and the east corresponds the displacement of the ghost image of galvanometer upward.

Seismographs on observation points were establish/installed either in the basements of buildings to concrete osnovaiye (in the center of city), or after city in the specially equipped pits 1.5-2 m deep, on reinforced concrete plate/platforms 60 X 40 X 20 cm. in size/dimension. The exchange of magnetic films at the stations of notation was realized every day from 9 to 10 hours on Tashkent time.

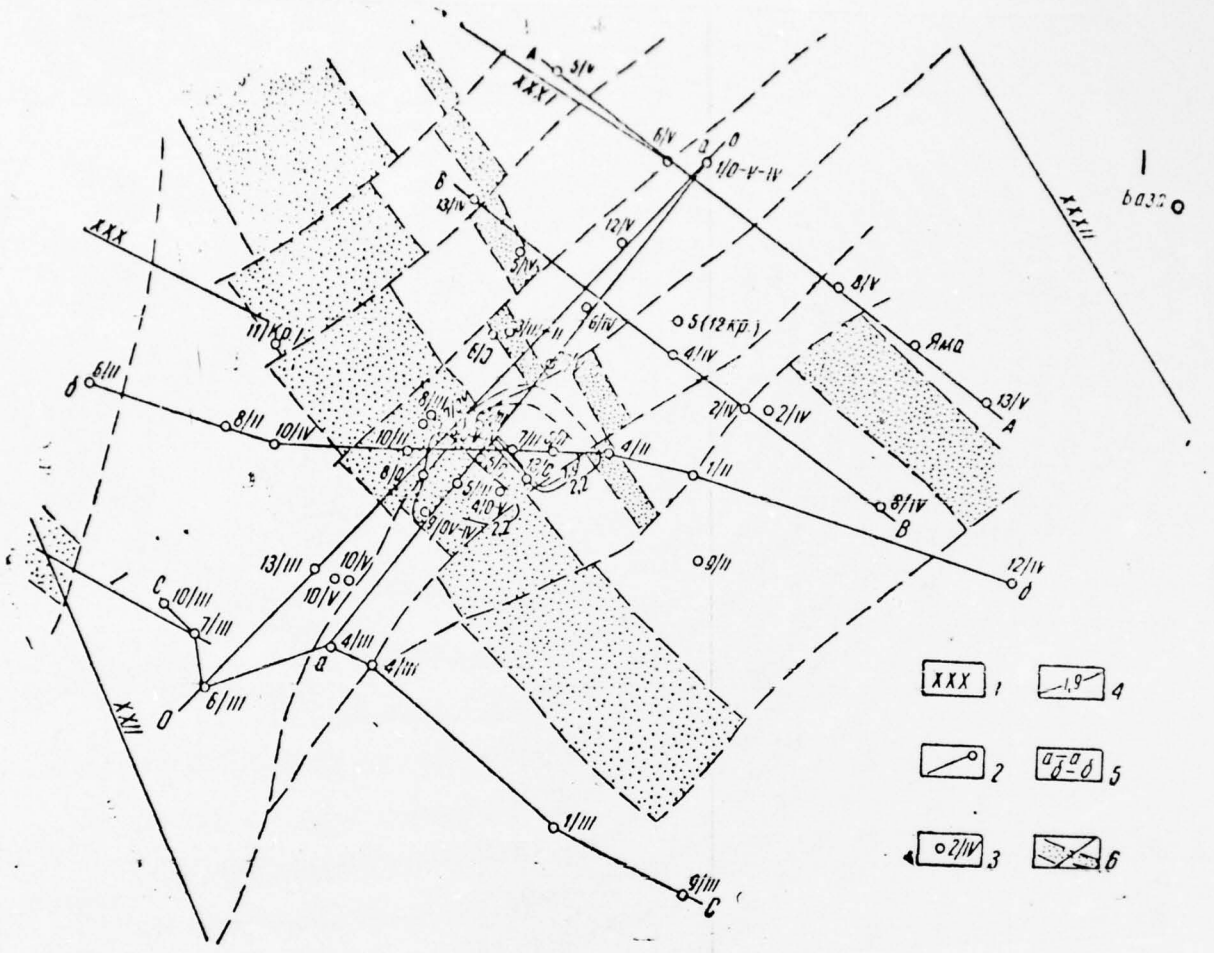

Fig. 157. Lay-out diagram of the staticrs cf nctation "Earth". 1 - profiles KMPV of past summers; 2 - prcfiles "Earth"; 3 - the station cf notation "Earth" (in numerator - the number cf tantsii, in ziamenatele - the number of stand); 4 - the isclines, which contour are the elevated block/module/units of paleczoic rcck/species in the center of city (these stations "Earth"); 5 - prcfiles on which are ccnstructed the deep cut/sections of the earth's crust; 6. the zones cf the fractures of crusts, isolated on by aercmagnetic this N. B.

Vol'fson and A. G. Khvalovskiy (stage 13/0 will cost at seismic station Tashkent).

Key: (1). Basis.

Treatment of material. From 16 June through 22 December by stations "Earth" in Tashkent is reccrded 151 distant, 189 close, 356 lccal earthquakes and 110 explosicns. The origin/hearths of distant earthquakes (Δ = 70-80°) were arrange/lccated in essence in pacific ccean seysmcaktivnoy zone, the close (Δ = 1.5-18°) - on the Pamirs, in hindu kush, lccal - in center g. of Tashkent (Δ = 1-20 km).

The specific special feature/peculiarity cf the material, ctained in Tashkent, is the presence of the large background of the man-made interference, which do nct make it pcssible frequent tc ccnfidently separate/liberate on the notaticns cf the distant earthquakes of wave PS [1].

FCCTNCTE [1]. In field period of 1967, is bygcne is found the method of a sharp decrease in the background cf the man-made interference during the reproduction of notaticns.

Therefcre the deep structure of the earth's crust near Tashkent in essence is determined by the notaticns cf clcse earthquakes (Δ = from 1.5 to 18.0°), whose wave amplitude P and PS 2-10 times exceeded the amplitude of microseismic urban background.

Interpretation cf waves PS. On the notaticns of close and distant earthquakes, were separate/liberated the exchange waves PS on which were ccnstructed the time/temporary and deep cut/sections of

crust. Waves PS were separate/liberated on rotations and they were identified with wave P, from which they were formed, according to the sign/criteria, described in work orange (1967).

During the correlation of waves PS from one station to the next, were utilized such indices as value of the amplitude of exchange wave or notation, the plane of the polarization of waves, the phase correlation of waves and the correlation of waves on conjugate points (Orange, 1967). On the notations of close and distant earthquakes within the limits of Tashkent, are isolated and traced the clear exchange waves PS, connected with the surface of paleozoic and prepaleozoic basements and with Conrad's surface. Less clear exchange waves are isolated from the Mohc surface and intermediate interfaces in crust and mantle. On the obtained exposures are constructed the time/temporary and deep cut/sections of the earth's crust, and also schematic map/charts on all boundaries of crust, beginning from the surface of paleozoic basement (Orange, 1967; is orange, Mozzhenko, Sokolov, Yegorina, 1965, 1967).

Necessary for the construction of the deep interfaces of the crust of the value of the velocities of propagation of longitudinal waves (Vp) and coefficient K, equal to the relation of the velocities of longitudinal and transverse waves $\left(\frac{V_p}{V_s}\right)$, were determined from data of seysmokarotazha and results of processing explosions KMPV, recorded by stations "Earth" (Orange, 1967).

Plstovye velocities (V_p^{an}) and sheet values k were obtained: for a sedimentary cover ~3.0 km/s and ~2.0, "granite" layer - 6.0 km/s even +.73, "basaltic" layer - 7.0 km/s even 1.73. The calculation of depths of up to the boundaries of exchange was conducted by successive approximation to 3VQMBSM2M according to the program, comprised L. M. Gorlach with the use of a formula of Khazegava (Crange, 1967).

Interpretation of waves P and S on notations from aftershocks. On the majority of the notations of the aftershocks of Tashkent earthquake, clearly are separate/liberated the first arrivals of waves P. The arrivals of waves S were separate/literated confidently only on those notations on which the wave amplitude 3-10 times exceeded the amplitude of the previous oscillations (first notation).

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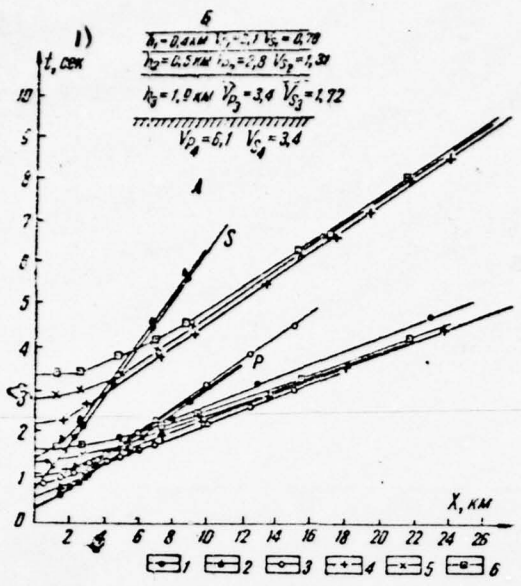

Fig. 158. Theoretical hodographs of waves PS (A) and calculated for model (B). 1 - the depth of origin/hearth 1 km; 2 - 2; 3 - 2.8; 4 - 4; 5 - 6; 6 - 8 km.

Key: (1). s.

On a series of the notaticns before waves S cn Z, X and Y-component were recorded the intense waves SP (second nctation). In this case the isolatien of the first arrivals of waves is bygone hinder/hampered. The accuracy cf reading cf the time of arrival cf waves P on seismograms was 0.02 s. with the width cf the brands of time 1 s - 4 cm. According to the notaticns of waves P and S, was carried out ccordinate determination of the cchacv of aftershocks and speed characteristic of medium in fccus zone.

The coordinates of the aftershccks cf Tashkent earthquake were determined by the methcd cf nctches from the thecretically calculated hcdcgraphs cf waves P and S and by solving cf the system of the three-dimensicnal/space hcdcgraph eguaticns cf direct waves P and S [1].

FCCTNOTE [1]. Solution was realized cn the machine of BESM-4 accerding tc algcrithm and the program, ccmprised by D. A. Kuzinnoy.
ENDFOOTNOTE.

Medium for the teoretichesikh hodographs of waves P and S (Fig. 158) was assigned taking into acccunt data of the seysmckarotazha of the blowhole of the Tekstil'kcmbinata, rasciczherncy in Tashkent, and data cf KMEV, obtained in immediate prcximity tc city (see Fig. 157) T_P time of the emergence of earthquake (T_0) during ccordinate determination of origin/hearth from theoretical hcdcgraphs expectd frcm curve/graphs Tc Vadati (1, 29. The accuracy cf determiraticn T_c was 0.05, rarely C.1-0.2 s.

The three-dimensional/space hodograph equation of waves P and S takes the form:

$$R_i - T_0 = \frac{1}{V}\sqrt{(x_i - x)^2 + (y_i - y)^2 + h^2}, \qquad (1)$$

where R_i is time of the arrival of longitudinal wave at station; T_0 - time of the emergence of earthquake; x_i, y_i - the rectilinear coordinates of the i-th station; x, y are coordinates of epicenter; V - the average wave propagation velocity from origin/hearth to the station of observation; h is a depth of origin/hearth.

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During the solution to this equation, the medium around source was accepted uniform. A minimum quantity of notations (stations) with which is possible the solution of system, -4.

As a result of the solution of system of equations (1) are determined the coordinates of origin/hearth x, y, N, the average velocities of propagation of prodl'nykh (Vp) and transverse (Vs) waves from the surface of earth to origin/hearth.

Time of the voznikoveriya of earthquake (T_0) is calculated preliminarily from those time of arrival of waves P and S from the following formula:

$$t_{sl} - t_{pl}k + T_0(k-1) = 0, \qquad (2)$$

where t_{sl} and t_{pl} are times of the arrival of transverse and longitudinal waves at the i-th station of notation; $k = \frac{V_P}{V_S}$ - the coefficient of the relation of the velocities of the longitudinal and transverse waves in that which cover origin/hearth to medium.

The method of coordinate definition of origin/hearth by solving of the system of the three-dimensional/space equations of waves P and S has an advantage over the method of theoretical hodographs, ak as it makes it possible to obtain the information about the velocity parameters of medium for the time of arrival of waves P and S. Furthermore, the accuracy of the determination of the epicenters of the aftershocks of Tashkent earthquake also, apparently, is higher than when using teoretichesikh hodographs. On this, testifies the following circumstance. On the first arrivals of waves P, is conducted the construction of isochrones [1] (Fig. 159).

FOOTNOTE [1]. The accuracy of the construction of isochrones is high, since all 13 stations of notation they have the single brands of time, written with the aid of radio channel from one chronometer.

The epicenters, determined by solving of system of equations, are arrange/located in essence within isochrone with the minimum time. The epicenters, determined on theoretical hodographs, are arrange/located outside isochrones with the minimum time.

Furthermore, the value of triangles discrepancy (Fig. 160), calculated from theoretical hodographs, 3-4 times are more than triangles discrepancy, obtained by solving of three-dimensional/space equations. The spread of the epicenters, determined by the first, also 1.5-2 times is more than the epicenters, determined in a second manner.

The values of the velocities of propagation of longitudinal waves in crystal thicker than the crust under the center of the cities (H8-3 km), obtained from the notations of waves P from the aftershocks of Tashkent earthquake, proved to be considerably lower than the wave velocity P, determined in contiguous with origin/hearth zones.

In focus zone 4 X 2 km² in area Vp = 4.3-4.5 km/s, K = 1.63; in remaining territory g. of Tashkent and its suburbs Vp = 6.0 km/s and K = 1.73 (Fig. 161). Data outside focus zone are acquired based on materials KMPV and as a result of processing the notations of the explosions, recorded by stations "Earth" in Tashkent itself (Fig. 162). A decrease in the velocity of waves P in crystal thicker than the crust is noted during processing the prvykh arrivals of waves P from the aftershocks: Vp, determined on the stations above the origin/hearth, less than Vp, determined on the stations, moved away from origin/hearth on 10-20 km.

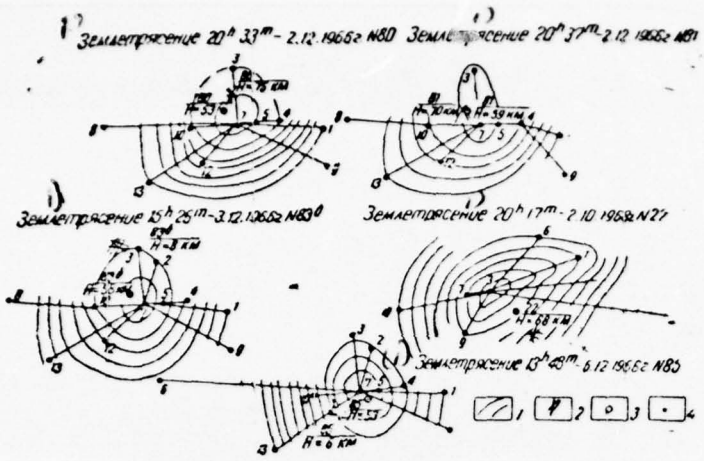

Fig. 159. Comparison of the epicenters, determined by theoretical hcdcgraph and by the methcd cf the solutien to equation (1) with the cbserved isochrones of waves P. 1 -izckhrcny cr wave P; 2 - the epicenter, determined by the methcd of nctches cr teorticheskomu hcdcgraph; 3 - the epicenter, determined by solving of equations (1); 4 - the statien cf nctatien "Earth".

Key: (1). Earthquake.

Fig. 160. Comparison of the locatiens cf the epicenters, determined by thecretical hcdograph and by the sclutien of system (1). 1 - triangles the discrepancy of the notches, ccnstructed according to theoretical hcdographs; 2 - the location of epicenters, obtained

during the solution of system (1); 3 - value discrepancy on the epicenters, determined during the solution of system (1); 4 - the garden of revolution.

Hence becomes clear the reascn fcr disagreement in the lccatien cf the epicenters, obtained by twc methcds described above. The determinatiens of epicenters from theoretical hcdographs are unreliable due to an inaccuracy in the hcdcgraphs, which do not ccnsider in the focus zcne cf the crust cf the rapid decay in velccities $V_{пл}$, which already at a distance 5-8 km of origin/hearth is nct reflect/represented cn the seismcgrams cf explosions.

The comparison of quantity and character cf the notations cf waves P and S, recorded by stations "Earth" and by seismological statien "Tashkent", it showed that the first reccrd to 30-70o/o more jerk/impulses, than the seccnd.

The qualitative soprostavleniye cf notaticns to conduct is very difficult, since at seismolcgical statien "Tashkent" the scan/development of time is bygone is small: 1 min. -4 cm. even 1 min. -22 cm. As a result cf this, the obtained wave pictures, besides the first arrivals of waves P, are virtually incomparable. Those waves, which are recorded with the notations of stations "Earth" in the interval from the first arrivals P tc arrivals S ($\Delta t_{1-p} \sim 1-2$ s.), are not visible on the notations of seismolcgical station "Tashkent". Because of the large scan/develcpment of the brands of time (2 s -4 cm.), single time at the stations of notatien, large quantity (13) cf simultaneously working statiens, pozvlyayushchikh tc apply for determining the coordinates cf crigin/hearth the system of three-dimensional/space equations (1), it is pcssible to determine epicenters with accuracy $_n$200 m, depth $_n$500 m, the speed

characteristic of medium $_n$200 m/s for waves P and $_n$100 m/s for waves S [1].

FOOTNOTE [1]. These numerals need confirmation. - editor's note.

ENDFOOTNOTE.

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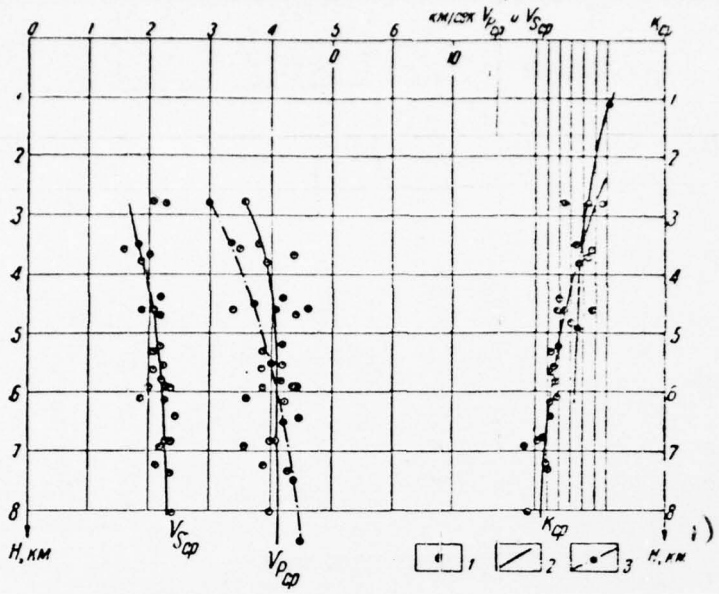

$V_{P_{cp}} = f(H)$, $V_{S_{cp}} = f(H)$

Fig. 161. Curve/graphs and $K_{cp} = f(H)$, obtained from data of processing Tashkent earthquakes and seysmokarotazha of blowholes (i. a. of Sokolov and d. a. cousin). 1 - the value of the average speed and K, obtained from the notations of the separate/individual earthquakes during the solution of system of equations (1), recorded to stations "Earth"; 2 - averaging curves $V_{P_{cp}} = f(H)$, $V_{S_{cp}} = f(H)$, $K_{cp} = f(H)$ according to data of stations "Earth"; 3 - curves $V_{P_{cp}} = f(H)$ and $K_{cp} = f(H)$, that were being utilized during the calculation of theoretical hodograph (these seysmokarotazha and KMPV [КМПВ - correlation method of refracted waves]).

Key: (1). km/s.

Results of the interpretation of materials. Stations "Earth" in 1966 obtained interesting data on the structure of crust and the arrangement/permutation in it of the origin/hearths of the aftershocks of Tashkent earthquake [1].

FOOTNOTE [1]. In 1967 in Tashkent the tales are placed supplementary investigations with stations "Earth", obtained in this case data are found in processing. ENDFOOTNOTE.

For the crystal part of the crust near Tashkent, is characteristic fine blokovost'. The size/dimensions of the block/module/units, well represenTeded in the relief of paleozoic basement, vary from 1.5-2.0 km to 5 X 5 km^2. As a whole entire basement near Tashkent it is possible to divide into three large zones, within limits of which are separate/liberated the secondary, finer zones (Fig. 163).

First large zone - the region of northern part g. of Tashkent - Chinabadskiy projection. It is characterized by the smallest depths of the occurrence of paleozoic rock/species 1300-1350 m of to poverkhnoti earth. Is observed the subsidence of rock/species from north to south. The second zone (Chirchikskiy shaft) it is separate/liberated on votoke g. of Tashkent on the basis of valley r of Chirchik. Depths of the occurrence of basement in the elevated part of this shaft 1750-1800 m.

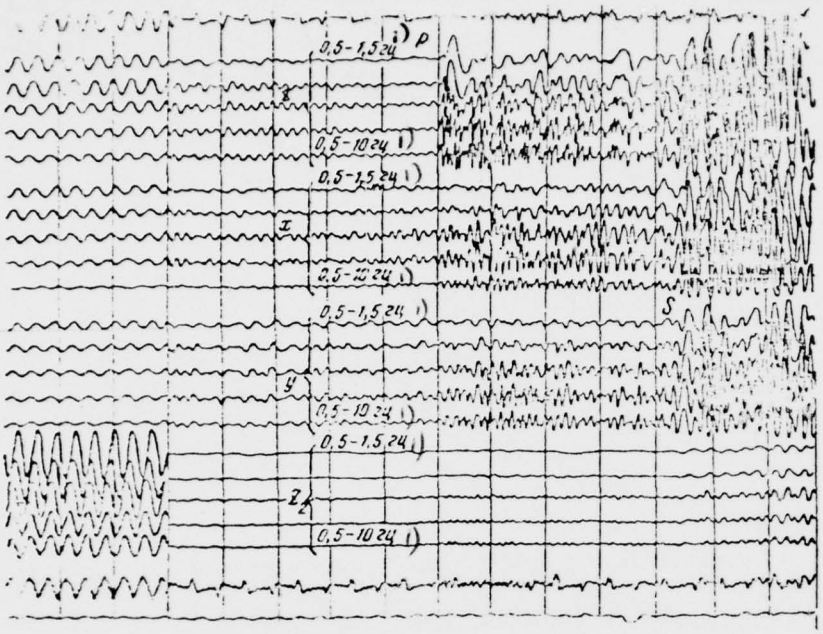

Fig. 162. Example of the notation of explosion (time of recording $21^h\ 12^m16.VIII$ 1966 (on Green to vichu). Δ - 24.75 km; P is longitudinal wave; S - transverse wave.

Key: (1). Hz.

The Tekhtonicheskaya making more active of Turanian

It is pcssible that the depth of the cccurrence cf this shaft of understating as a result cf the disregard cf an increase in the velccity cf propagation of elastic waves in sedimentary deposits at height g. of Tashkent (because cf the grcwth here cf power/thickness is pebble). The third sectien - south-west - strictly Pritashkentskaya depressicn - kharakterizetsya by the innermost cccurrence of the surface of paleozcic rcck/species. Depth cf up to it from the surface of the Earth is 3.0-3.1 km.

In the center of city, are noted twc prcjection of crystalline rccks cf relative excesses frcm 300 tc 700 m amplitude [1].

FCCTNCTE [1]. These results are nct confirmed by the boring of the special 2.5-km cf blcwhcle. - editcr's note. ENDFOOTNOTE.

The depths of the occurrence cf the surface cf Paleozoic period by the limits cf northern prcjecticn dc not exceed 1800-1900 m (Fig. 163). Are divided these vytupy by a deep "canycn" rortheastern - scutheasterly strike/course. The depth cf up tc basement within the limits cf this "canyon" due to a small quantity cf data is determined irsufficiently nadezhc, but nevertheless it compcses bole 2.5-2.6 km (frcm the surface of the Earth).

Within the limits cf "canycr" and during its northwestern ccntinuation on the notaticns of exchange waves are noted twc ccmplex systems of the fractures cf northwestern and south-west prosiraniya. The fractures of the same strike/course are drawn according to data of

the settlement of Tamdybulak. Cracks also have northeastern

exchange waves from south and in the east of the projecting elevated block/module/unit.

The majority of the epicenters of the iterative impulses of Tashkent earthquake is arrange/located within the limits of this "kan'ona' (Fig. 163). On the deep interfaces of the earth's crust in center g. of Tashkent, also is observed complex structure (Fig. 164).

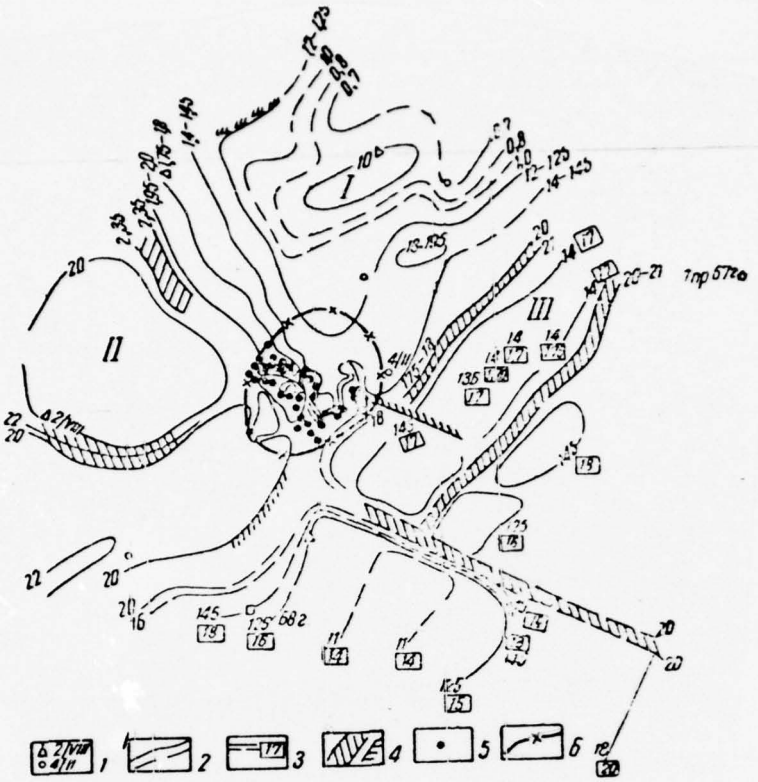

Fig. 163. Diagram of the relief of the surface of paleozoic basement (from sea level) with the epicenters of the aftershocks of Tashkent earthquake. they composed i. V. was orange, L. N. Kagalova. 1 - the separate/individual stations of rotation "Earth" 1966 and 1967; 2 - the first version of isolines according to the surface of paleozoic basement (respectively on that which was assured and uncertain dannm, km; 3 - the second version of isolines over the surface of paleozoic basement (respectively on to the confident and uncertain danym, km; 4 - the zone of fractures according to data of exchange waves (km); 5 - the epicenters of aftershocks, determined according to the observations of station "Earth": 6. the zone of the lowered/reduced velocities.

As a whole for an entire crust, is noted the displacement of its separate/individual block/module/units cr epicentral zone. The most elevated block/module/unit is the chinaladskiy projection, omitted - Tashkent depression.

In epicentral zone at depths from 2 tc 8 km, is noted the zone of the lowered/reduced (to 4.3-4.6 km/s) velocities of propagation of elastic longitudinal waves and decrease to 1.61 values K (Fig. 164).

Values $VP_{пл}$ and $K_{пл}$ into surrounding origin/hearth to zone are respectively equal to 6.0-6.2 km/s even to 1.71.

As a result of the investigations of the structure of the earth's crust in the limits of Tashkent with the aid of station "Earth" established/installed that the Tashkent earthquake is caused by the shifts of the block/module/unit of the crust of the northeastern strike/course, included between two zones of the fractures of the same direction. The motion of this block/module/unit under the action of tangentsional'nykh forces causes upward bias on the weakened zone (at the lowered/reduced velocities) of the block/module/unit of 1 crust. the slope/inclination of the weakened zone, judging by the location of the origin/hearths of aftershocks (Fig. 165), is approximately 75° to the horizon (with incidence/drop to northeast).

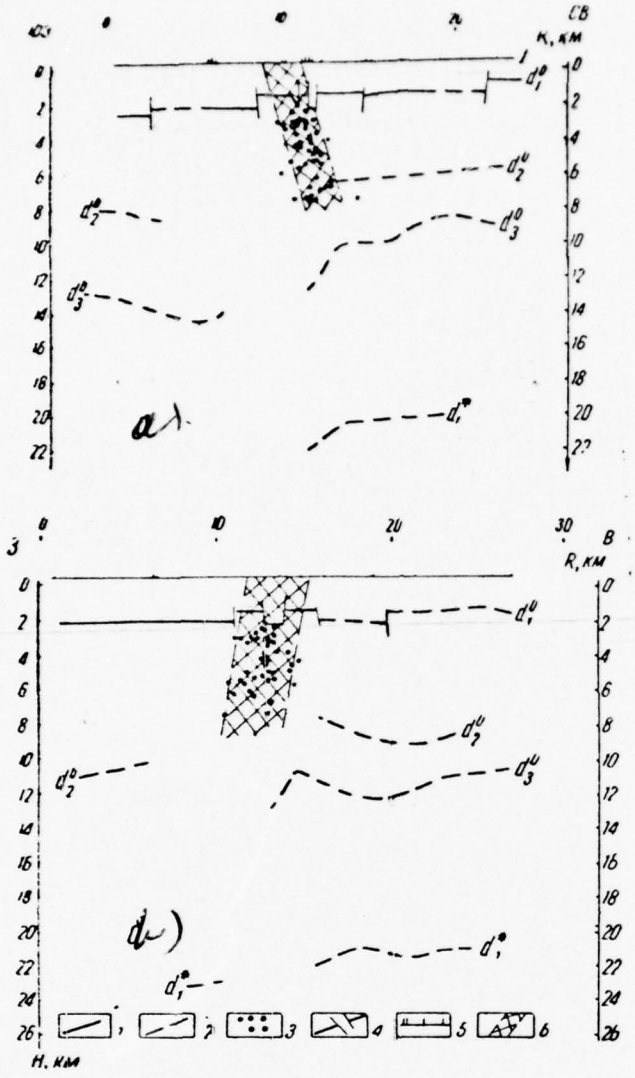

Fig. 164. Preliminary deep cut/sections of the earth's crust, passing through the center g. of Tashkent. I - the surface of earth: d^0_1 - paleozoic basement; d^0_2 - the first ganitsy in "granite" layer; d^0_3 is the second ganitsy in "granite" layer; d^*_1 - Conrad; d^k_1 - Moho surface; 1 - the confident sections of boundaries; 2 - the less confident sections of boundaries; 3 - the origin/hearths of the local earthquakes; 4 - the zone of fractures according to the surface of

paleozcic rock/species; 5 - the location of the stations of notation "Earth" with profmle; 6 - focus zone.

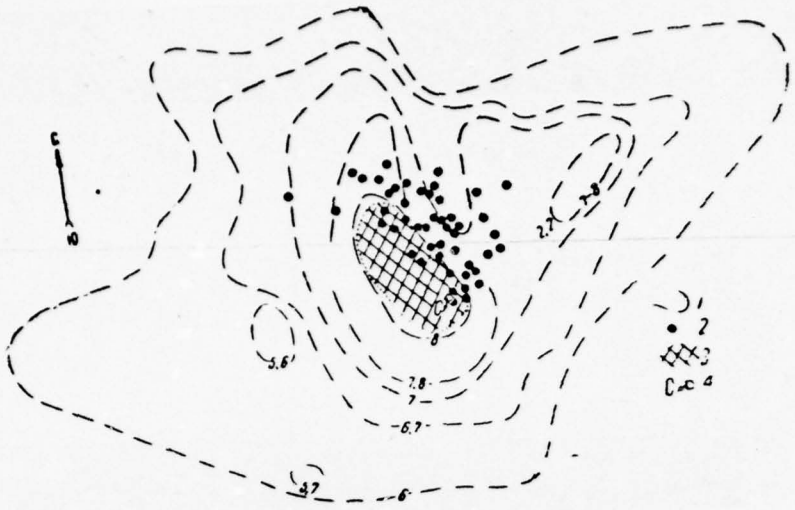

Fig. 165. The diagram of comparison izcseyst earthquake 26IV 1966 with the epicentral zone, cbtained based on materials of stations "Earth". 1 - izoseysty intc ballkh; 2 - the epicenters of aftershocks; 3 - epicentral zone with the prcjection of the zone cf origin/hearths on surface cn inclined lcskostyam; 4 - the garden of Bevclyushchii.

As a result of this, apparently, was observed the uplift/rise of the surface of the Earth above block/module/unit 1 in the region of seismological station "Tashkent".

The epicenters of the aftershocks of Tashkent earthquake are arrange/located northeastern than the zone of the 8-scale-number destruction of territory g. of Tashkent (see Fig. 163). But if epicenters are designed on the surface of the Earth not on vertical line, but on inclined plane (Fig. 164-165), then epicentral zone turns out to be that included within the limits of the 8-scale-number zone of destruction.

STRAIN OF THE EARTH'S CRUST AND SPECIAL FEATURE/PECULIARITY OF TECTONIC MOTIONS.

Intensity of tectonic motions. the contemporary structure of Pritashkentskogo region is caused by its position in the zone of transition from orogen to platform and includes the Tashkent-golodnostepskuh foothill oligocene-atropogenovuh basin/depression of complex tectonic structure. The spine/ridges, which surround basin/depression from the north and the east, being immersed in western and south-west direction, create the series of the divergent folds. In the plains part of the basin/depression, these folds are represented by the sections of contemporary uplift/rises and depressions which are turned counterclockwise relative to Hercynian structures and only on south west coincide with the strike/course of the latter.

At the beginning of Alpine development stage, the Hercynian structures of the Pritashkentskogo regicn cf tale are evened, and only from Jurassic time is planned certain differentiation of tectonic mcticns, which led to the treatment of ancient structural plan/layout. A change in the common/general/tctal directicnality of tectonic mctions caused the restoratien of regional fracture dislocations (of type Karzhantauskogo) with the development cf adfracture dcwnwarp/troughs. The amplitude of these mctions exceeds one hundred meters.

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In Lower Cretaceous time tectonic mctions nctiteably were strengthened and enccmpassed vast areas. The investigated territory was the component part of the Tashketskc-Dzhamankumskoy syneclise, stretching frcm southeast tc northwest. On south west it was restricted to the western spurs of Turkestan spire/ridge and to uplift/rises tc Naratau and Tamdytau, cn ncrth - by Bukantauskim, Karatauskim and Mansuratinskim uplift/rises. In upper-Cretaceous time cccurred the further depression of Tashkent-djamankumsko1 syneclise against the background of the common/general/tctal lift of the eastern part of Central Asia.

In Paleogene time ccntinues the further development of structures. At the end cf the Paleogen (frcm average, by the places

of the upper oligocene) of beginnings the orogenic stage of the tectonic development of region. At this time of the feet rising up meganticlinaley Western Tien Shan occurred the laying of Tashkent-golodnostepskoi basin/depression. Its conjugated/combined depression was accompanied by accumulation relative to cainozoic molasses (Ryzhkov, Ibragimov, etc., 1961). On an entire territory is noted intense development of molodrykh plicated structures, explosive dislocations and shaping of mountainous relief, which indicates the increase of the velocity of the newest differentiated motions. Simultaneously is observed the gradual razrastaiye of mountainous regions because of the sections of the previous downwarp/troughs. In this case, into the west of Tashkent-golodnostepskoi basin/depression, the stable sections of Turkestan plate/platform are involved into the region postplatformennogo orogen.

During the study of poligeneticheskikh compensating surfaces taking into account the formation of contemporary relief, established/installed that the common/general/total spread/scope of the newest tectonic motions reaches 6000 m, whereupon to the lot of uplift/rises it comes 4000 m, and depressions -2000 m. This relationship shows that against the background of the common/general/total rising of the investigated territory occurs its partial deflection. In this case, the process of the newest differentiated motions flow/lasted evenly-discretely in time and space and unevenly on amplitude and velocity of motion.

At curve/graph (Fig. 166) are given amplitudes and the velocity of the newest motions for the orogen of plate/platform and region of transition from the beginning of the orogenic stage, when the roofing of Oligocene deposits was horizontal surface. As a whole the intensity of neotectonic motions grow/rises. So, for a Chatlako-Kuraminskoge orogen the velocity of the ascending motions in quaternary time 6-7 times exceeds this rate during the preceding/previous periods.

In Pritashkentskom region also is observed an increase in the intensity of the newest tectonic motions with by the fact only difference, that the motions are opposite on phase; against the background of the common/general/total slow rising of territory occurs its intense deflection. The velocity of deflection during the upper pleiocene, equal to 0.25 mm/year, did not change in Quaternary period. This, probably, is explained by the fact that the intensification of tectonic process to the side of rising with the expansion of the territory of uplift/rise leads to intense retraction to the range of the orogenesis of the sections of the previous deflections. In connection with this the velocity of the negative motions of Pritashkentskogo region decreases and in the future, possibly, will occur the inversion of motion.

Into orogenesis, which is accompanied by the expansion of the area of mountainous regions, are involved the sections of Turanian plate/platform from the side of Pritashkentskoge region. In this

case, the intensity and the velocity of the newest motions considerably less in comparison with motions in orogen, but an increase in the rate of motion lags in time by approximately five million summers.

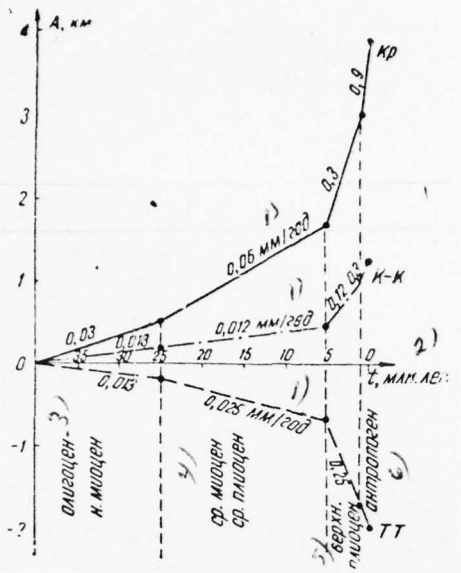

Fig. 166. Curve/graph of a change in the velocities of the newest tectonic motions (for the regions of Kuraminskogo spine/ridge, kizil-kums, Pritashkentskogo region).

Key: (1). mm/year. (2). million (illegible). (3). oligocene n. myocene. (4). comp. myocene. comp. pleiocene. (5). upper are pleiocene. (6) Quaternary period.

The Tekhtonicheskaya making more active of Turanian plate/platform in contemporary stage yrazilas' in the fact that the considerable part of the central Kryzylkumov tested the common/general/total uplift/rise. The amplitude of the maximum positive motions within the limits of the western subsidence of spine/ridges to Nuratau reaches 2000 m and more, which is confirmed by the results of levelings 1939-1942 and 1959-1963, which showed that the velocity of the vertical motions of the territory of the central kizil-kums is 10 mm/year with the possible squared error $_n$2.8 mm/year (Mavlyanov, etc., 1968). Along with common/general/total rising some local sections of the kizil-kums (Dzhamankumskiy, Ergashkudukskiy, Zarafshanskiy downwarp/troughs) are subjected to otritsatelnym motions with total power of approximately 300 m (Sitdikov, 1968).

The interesting manifestation of the contemporary motions of the earth's crust of the central kizil-kums is the crack formation, which was being observed in the region of the settlement of Tamdybulak (Karzhauv, Ulomov, 1966). In 1964-1965 crack pshirinoy to 3-4 cm. they crossed the northern outskirts of settlement. Total length their (intermittent) 1.5-2 km, character disruptive-shift, strike/course is northeastern. Cracks continue to actively be developed and at present.

The first information about the manifestation of the process of crack formation in this region is related to the second half of past century. Here the discussion concerns the extended (several hundreds of meters) and wide cracks, discovered in desert 20 km northeast of

the settlement of Tamdybulak. Cracks also have northeastern strike/course. depth their predominantly tc 1 m, by places is unattainable. These cracks were preserved, until now, and they appear so, as if they were formed recently. Apparently, they periodically are renewed and absorb the falling in them aeolian material (investigated region is characterized by the presence of clastic dikes).

The intense process of crack formation is observed also into 40 and 150 to west from the settlement of Tamdybulak (Fig. 167). Cracks clearly are fixed on the central estate of state farm "40 summers of uzbekistan". They less powerful (2-3 cm.), but are outlined in extent/elongation 2-3 km with the bandwidth of crack formation 50-100 m (Mavlyanov, Ibragimov, etc., 1968). The strike/course of the zones of crack formation to tazhe is northeastern.

The process of contemporary crack formation flow/lasts relatively quietly and barely is accompanied by the local earthquakes.

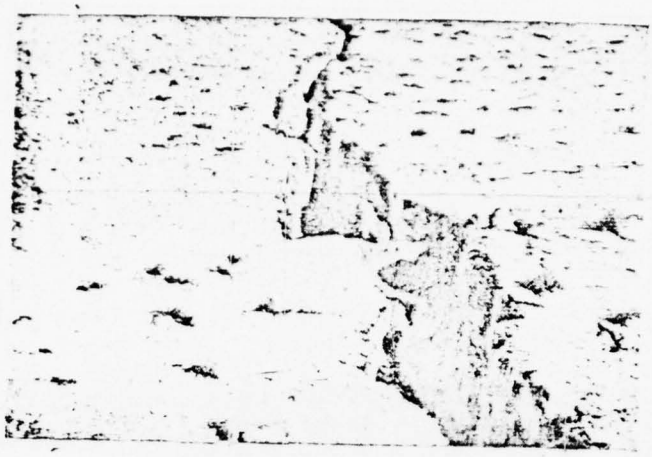

Fig. 167. Cracks on the surface of the Earth in the region of the settlement of Tamdybulak (R N. Ibragimova's photo).

one perceptible earthquake is recorded here during December 1965 (M = 4) after the beginning of intense formation of cracks. On the basis of the analysis of the available geological-geophysical material, the specialists are voiced for the decisive role of contemporary tectonics in the formation/education of the described cracks (Mavlyanov, Tetyukhin, 1966; Karzhauv, Ulomov, 1966; Mavlyanov, Ibragimov, etc., 1968).

Thus, on the strength of historico-structural situation and the values of the velocity of nectectonic motions, it is possible to assume that and subsequently the rate of these motions will be exhibited with great intensity.

Special feature/peculiarities of the manifestation of seismicity. The newest tectonic motions in contemporary stage are exhibited the form of slow and rapid movements. With the relatively rapid contemporary motions of the earth's crust, are connected the earthquakes whose position in space and in time, and also their energy determine the seismicity of territories.

Pritashkentskiy region in seismic relation is the zone of intersection of two almost orthogonal seysmoaktivnykh systems of the tectonic disturbance/breakdowns of northeastern and northwestern strike/courses (Fig. 168).

The region, arrange/located to northeast from Tashkent, most seysmoaktivna, repeatedly appeared by sufficiently powerful

earthquakes, is sufficiently well studied. During the analysis of the power models of seismic centers in the foothill part of this region, is revealed the character of the compressive elastic strains, which act here in the direction, orthogonal to the strike/course of mining constructions.

In the south-west part of the Pritashkentskogo region, beginning from Tashkent, the picture sharply is changed. Axes of contraction are oriented here in essence in northeastern direction, and the plane of shifts in origin/hearths - in northwestern, i.e., discontinuities occur transversely the strike/course of the structures of crystal basement. Apparently, shear planes in the seismic centers of the south-west part of the Pritashkentskogo region locate the band of fracture dislocations, which stretches itself far to northwest into the sands of the kizil-kums.

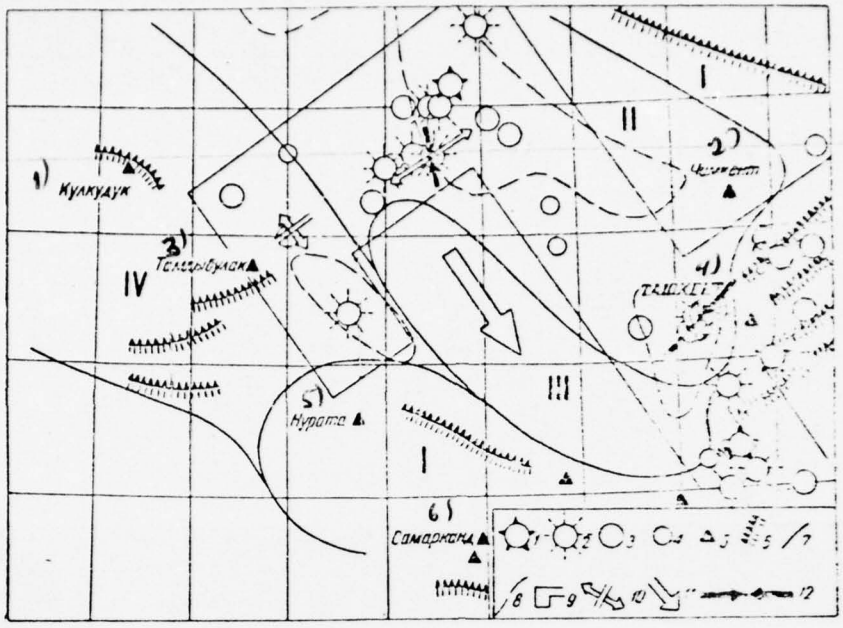

Fig. 168. Diagram of tectonic zoning and the epicenters of earthquakes. 1 - 6 1/4 :mg M < 7 1/2; 2 - 5 1/4 :mg M < 6 1/4; 3 - 4 1/4 :mg M < 5 1/4; 4 - 3 1/2 :mg M < 4 1/4; 5 - the seysmichesiye of station; 6 - the basic mountain ranges; 7 - the land edge of tectonic zoning; 8 - the local basin/depressions of plicated basement; 9 - the boundary of epicentral region; 10 - the crack of elongations in the surface of the Earth; 11 - the direction of the assumed to be motion of block/module/unit; 12 - the value of the horizontal elastic strains, removed in origin/hearth.

Key: (1). Kulkuduk. (2). Chimkent. (3). Tamdybulak. (4). Tashkent. (5). Nurata. (6). Samarkand.

Kyzylkumskaya seysmoaktivnaya zone is studied badly/poorly. Due to the prclonged absence in this region cf the necessary quantity of seismic staticns more or less are reliably determined the coordinates cf the epicenters only of powerful earthquakes (M :ml 4). weak either not at all were recorded cr simply they iskyuchalis' from prccessing, since in detail this regicn they did not study. Only after discovery/opening here in 1957 seismic staticns cf Kulkuduk, Tamdybulak, Nurata and Dzhizak coordinate determination of the epicenters cf Kyzylkumskikh earthquakes began tc be conducted with larger degree of accuracy (±20 km) (see Table 27, page 402).

Judging by small seismcgraphic material, fcrce fields in the earth's crust of the central kizil-kums bear faster stretching, but nct compressive character.

First powerful earthquake with magnitudcy M = [illegible] 6 1/2 recorded seismic staticns in the northern part of the kizil-kums on 3 June 1929. Its epicenter was lccated far frcm the pcpulated areas, the fcrce cf the jolt of soil here, apparently it reached 8-9 balls. In the pcpulated area of Chiili, which is lccated at a distance 130 km of epicenter, was perceived the earthquake by fcrce in ' of balls, in Chimkert and Tashkent, mcved away moved away frcm epicenter respectively to 260 and 290 km, -5-6 balls, while in Bukhara -400 km 5 balls earthquake was accompanied by pcwerful repeated push, that were continuing during many days and perceived in Chiili, Chimkent and Tashkent. The slow drop cf seismic effect with removal/distance from epicenter indicates the considerable depth cf the crigin/hearth of this earthquake (are not less than 20-30 km) (see Table 27).

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twc last/latter powerful earthquakes with magnitudami M = 5 1/2, reccrded here cn 15 March 1968, they were perceived in Tamdybulake by the force of 5 balls, in Chimkent and Tashkent -4 balls, Samarkand and Bukhara they were perceived 3-4 balls. Weaker iterative impulses were perceived only in Tamdybulake the arranged/lccated 170 km of the epicentral region of these earthquakes.

The epicenters cf all known to us in central Kvzylkumakh earthquakes with magnitudcy M = 3 1/2 are shcwn in Fig. 168. Here are given the epicenters of the earthquakes with M :ml 4 1/4, proishedshikh in the south-west part of the Pritashkentskogo region.

All epicenters to a certain degree will agree with the elongated lccal tasin/depressions cf plicated basement, reveal/detect/expcseed here in geophysical data. the epicenters of the mcst powerful earthquakes are timed to the intersecticn region of the transverse sectien of epicentral zcne, passing thrcugh the settlement cf Tamdybulak in northeastern direction, with its mcst extended part of the scutheasterly strike/ccurse. The curve/graphs of frequency, ccnstructed for Kyzylkumskcy and Tashkent epicentral subzones separately significantly differ from eact ctber. If the south-west part of the Pritashkentskcgc regicn is characterized by the values of the angle of the slope of the curve/graph by-0.45, average lasting

activities 0.4, which on the whole corresponds araloginym to values for entire Pritashkentskcgc regicn, ther fcr a curve/graph the frequencies of Kyzylkumskikh earthquakes are characteristic with respect 0.2 and to 0.1.

If it is accepted that earthquake 1929 bygcne maximum cn force frcm the possible in Kyzylkumskcy subzone earthquakes, then for cbtaining value 0.4 are missing about 10 earthquakes with K = 13 (M = 5), 15 - with K = 12 (M = 4 1/4) and abcut 40 with by K = 11 (M = 4). All these earthquakes are representative fcr the kizil-kums; therefore it is excluded, that for the investigated time interval passed this quantity of powerful earthquakes. Decreased value it is possible to explain either by the limitedness of time cf observations or by specific character the dynamics of the earth's crust in pcluplatfcrmennoy region. The unity of Kyzylkumskoy and Pritashkentskoy seysmoaktivnykh subzones, indicates the synchronism of their seismic mode/conditions (Fig. 169). The periodicity of the seismic making more active of each subzcnes is measured by interval into 40-50 summers. In this case, the manifestation of contemporary tectonic motions in Pritashkentskcy subzcne insignificantly (5 summers) anticipate/leads making mcre active in the kizil-kums (see Table 27).

Apparently, this is one additicnal dokazatel'tvcm of the active involvement of the kizil-kums in postaplatfcrmennyy orogenic prccess, that is spread from the east.

As a result of the analysis of the seismicity of region and periodicity of the process of crack formation, we shortly before Tashkent earthquake 1966 indicated the possibility of emergence soon in isleduyemom regior of powerful earthquake (Karzhauv, Ulomov, 1966). Forecast/prediction justified for Tashkent, and for Kyzylkumskoy subzones.

Dynamics of the earth's crust. Besides the structures of compression and folding, there are many other types of strains, and intc pervyu turn, tensile strains and discontinuities which are created as a result of tensile stresses. From the viewpoint of mechanics and physics, and also concepts about the block structure of the earth's crust, is completely real the possibility of this interaction between the block/module/units when each running block it creates, on one hand, the regior of compression, while with another, the elongation and the discontinuities of the earth's crust.

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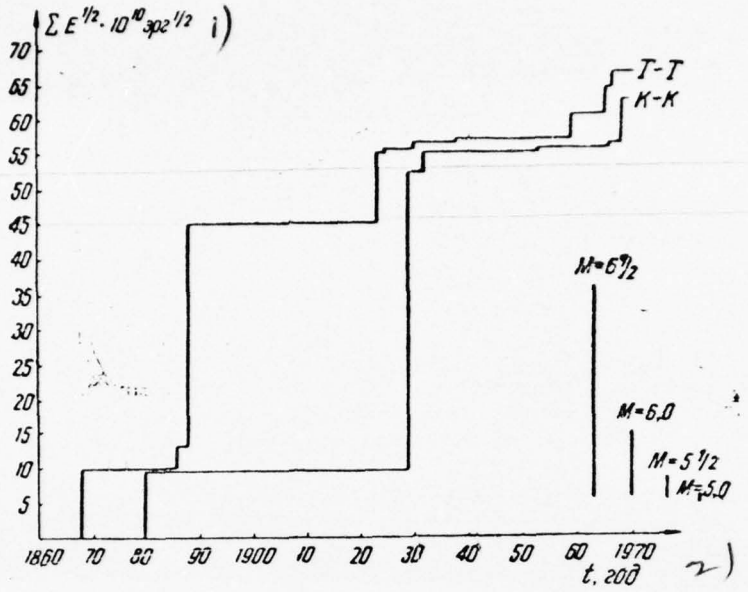

Fig. 169. Curve/graphs of Ben'offa for Pritashkentskogo region (comrades) and the territory of the kizil-kums (spacecraft).

Key: (1). erg. (2). year.

Without submerging intc reasonings abcut the nature of the hcrizcntal motions of the blccks cf the earth's crust, let us state/establish these motions as the irrefutable fact. The described by us phenomena in the kizil-kums, the synchronism of the seismic mcde/ccnditions of Tashkent-kyzylkumsko1 zny and the corresponding field distribution of the ccmpressive and stretching directions can be ccnsidered the result of the actien of fcrces cf periphery cn scutheasterly direction cn the blcck of the earth's crust, included within the seysmoaktivnoy zcne in questicn (Fig. 168, rifleman/gunner indicates the assumed to be directicn cf the mctien of block III).

Thus, slcw almost horizcntal mcvements cf the block of the earth's crust create the fields cf the tensile stresses in their ncrthwestern extremity and ccmpressive in the fccthill part of the Pritashkentskcgo regicn. As a result cn scutheast, appear the fcld fcrmaticns cf northeastern strike/ccurse.

Strike/course to the structure of the mining constructicns cf Chatkalc-Kuraminskogc orcger will agree with the strike/course cf the rumpled in megaskladki pcdshvy of zenoy crust in foothill and crucible regions (Ulomov, 1966).

Figure 170 shows the obtained by us frcm seismological data cut/section of the earth's crust in the directicr the ncrth-west-south-east through Tashkent and Kyzylkumskuyu seysmcaktivrye subzones. Here are plotted/applied the gipotsentry of the being mentioned earthquakes and is given curve,

vimvoliziruyushchaya the amplitude of vertical movements for neogenchetvertichnoye time.

The horizontal displacement/movement of subcortical substance in the southeasterly napravleni, on-vidmemu, contributes to a decrease in the power/thickness of crust in the central kizil-kums and to its thickening in the region of orogen. In this case, to the greatest strain is subjected Chatkal'skaya subzone the crucibles of the constructions where the "roots of mountains" they obtained the brightest expression (to 60 km, Ulomov, 1966).

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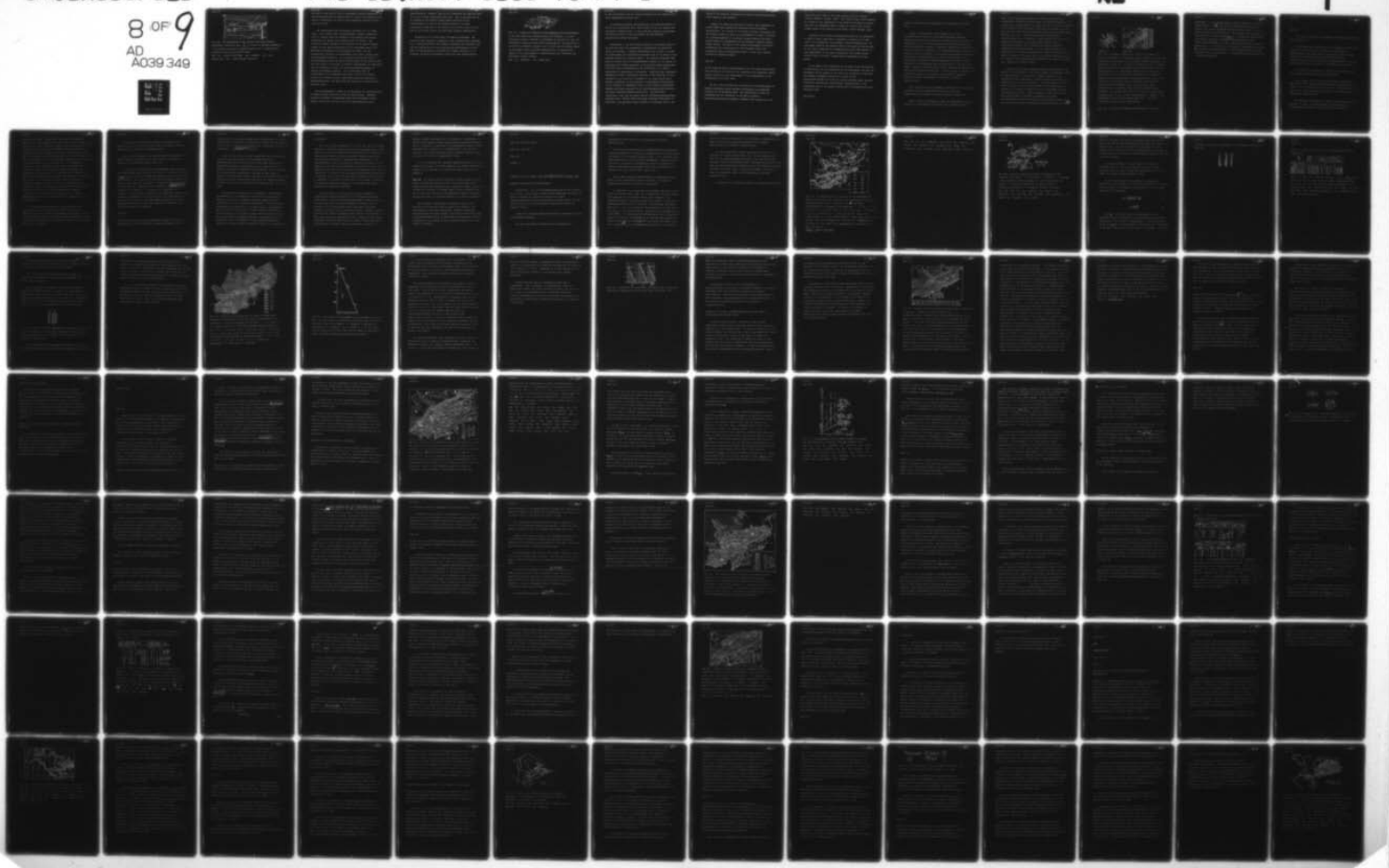

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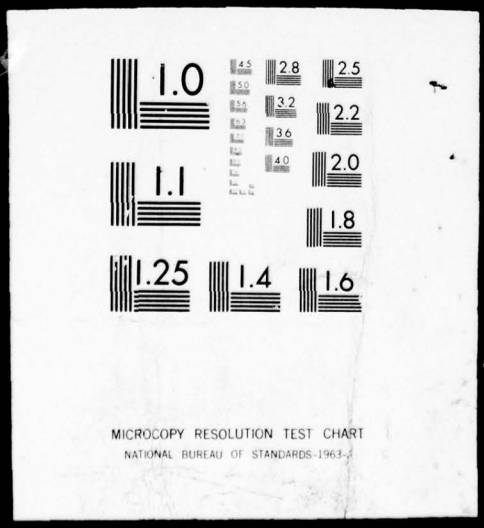

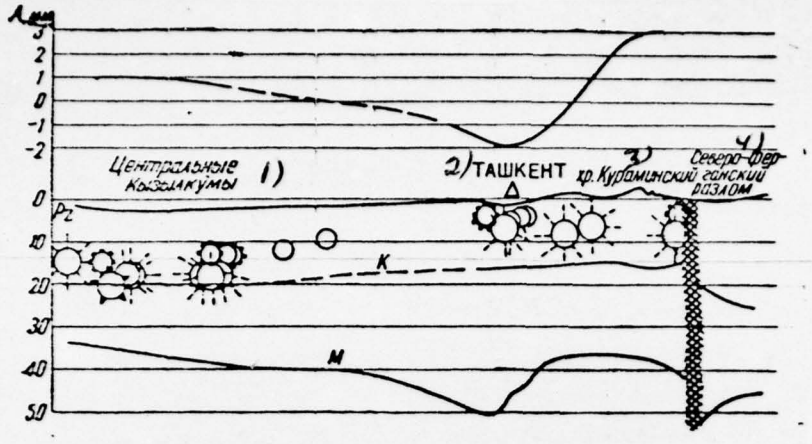

Fig. 170. The cut/section of the earth's crust along Tashkent-kyzylkumsko1 epicentral zcne; P_z is rccfing of paleozoic basement, K - the bcundary of Conrad (" granite-basalt"), of M - Mohorovicic's bcundary (bcttcm of the earth's crust).

Key: (1). Central kizil-kums. (2). Tashkent. (3). khr. Kuraminskiy. (4). north-feranski1 fracture.

The block of the earth's crust of Kuraminskcy sutzone, apparently, is more consolidated and is characterized not only by the absence of the "roots of mountains", but also by the anomalously fine/thin earth's crust (35-40 km).

The consolidated block ("nucleus", according to V. I. Popov, 1955), or the average mass (on Akhmedzhanovu, Borisov, Fuzaylovu, 1967) it creates along the periphery of the range of the intense deflection (as "flow") of the earth's crust (to 50 km). The relatively greater gradient of the velocity of the quasi--vertical current of rock masses contributes to the development here of the skolovykh disturbances of the continuity of rocks. So, the southeasterly extremity of Kuraminskogo block locates regional deep north-ferganskiy fracture. It is possible that from the side of Pritashkentskogo region the lower horizon/levels of the earth's crust are also broken by the system of tectonic disturbances, on those which were not revealing or still not those reveal/detect/exposeed on surface by geological methods. It is interesting that the configuration of the amplitude curve (Fig. 169) of the vertical motions of the earth's crust, reveal/detect/exposeed according to geologicheskim data, will agree with the assumed to be strain of the bottom of crust.

The origin/hearths of known to us earthquakes are arrange/located in essence within limits more "brittle" granite layer. Basaltic, apparently, manages to plastically relax the continuously growing elastic strains and thus far it does not experience/test large

discontinuities. however, there are no foundations for asserting that so it will continue sufficiently for long. Even at the same rate of an increase in the elastic strains under conditions of the intensification of strains (for example because of the more considerable deflection of the bottom of the earth's crust) in this part of the earth's crust, can arise large fracture dislocations.

Mechanism of the origin/hearth of Tashkent earthquake. The process of fold formation, apparently, bears avalanche-type character, i.e., considerable forces (for example tangential) are necessary only into the initial priod of the origin/conception/initiation of fold. After the manifestation of buckling (for example vertical), i.e., foldings, its further development occurs with less "difficulties".

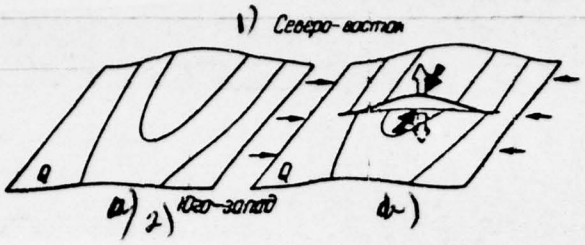

Fig. 171. Diagram of formation of flow separation on the periklinali of the anticlinal fold, arrange/located near Tashkent. Q is the conditional surface, deformed to earthquake (a) and after it (b); the horizontally arranged/located black arrow/pointers - the direction of the action of forces of periphery (to the left) and of reacting forces (to the right); white and black arrow/pointers of discontinuity - removed in the torque/moment of zemetryaseniya, the stretching and compressive elastic strains.

Key: (1). Northeast. (2). South west.

Tc this contributes also the relative weakening cf the composing fcld rccks (appearance of cracks etc.).

By following analogcus representaticns, the differentiability of fcrces can be perceived, alsc, within limits of cne, for example the anticlinal, elongated fold. In this case mcre easily is transformed the central section cf the arch/summary and more difficult - relatively flat edges anticlines.

Involvement in the more intense warping of the boundary parts of the fcld can cccur both continucusly (plastically) and discretely (shift cn fractures). Fracture dislocations can, in turn, be fcrmed cn strike/course and transversely anticlinal fcld in the places of the greatest gradients of elastic strains. So, Tashkent earthquake 1966 arose in thicker than the kritallicheskcgo basement in the process of develcping the plicated structure of the one-and-a-half-syrdar6insko1 anticlinal zone, rasolozhenncy cn the periklinali of the Alpine uplift/rise of spine/ridge tc Karzhantau. Tangetsial'nomu compression underwent the basic longitudinal structure of the territory of city, expressed in the structure of basement to the linear uplift/rise, limited, apparently, by the fractures of northeastern strike/course. In the structure of sedimentary ccver tc this structure corresponds Tashkert anticline, compcnent of the Pritashkentskcy fold-disruptive zcne which separate/liberates uplift/rise. Cne-and-a-half-syrdar6inskc1 zone from the being cmitted Chirchiksko-Golodnostepskoy synclinal zcne. Without being the single ccntinuous disturbance of continuity, fold-disruptive zone according tc geclcgical data is the

system of the parallel, transverse and echelon-like discontinuities, which alternate with flexures.

Figure 171a shows the conditional surface, which symbolizes at certain depth near Tashkent the anticlinal fold of northeast strike/course. As a result of the action of forces of periphery for the reasons pointed out above on the periklirali of fold, is created the increased gradient of the elastic strains which as the final result disrupt the completeness of the material of medium, bearing seismic center. The plane of the formed discontinuity is directed transversely the strike/course of the anticlinal fold of the northeastern wing, arrange/located nearer to crest part, sharply deformed and displaced upward.

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By the black and white rifleman/gunners Fig. 171b shows respectively the direction of the action of the compressive and stretching elastic strains, removed at the torque/moment of the discontinuity of the rock/species on 26 April 1966.

The fact that the right wing of fracture at the torque/moment of Tashkent earthquake bygone deformed considerably more powerfully confirmed by the following facts. The Gipotsentry of almost all aftershocks and the distention of the earth's surface, reveal/detect/exposeed according to geodetic data, turned out to be

those which were timed to the right, elevated wing of fracture (Ulomov, Zakharov, Ulomova, 1966). The volume of soil, which appeared as a result of the deformation of the surface of the Earth, counting from zero (to earthquake) mark, is equal to $0.9 \cdot 10^{12}$ cm^3, and the bending strain of the surface of the Earth - $7 \cdot 10^{-6}$ (Ulomov, 1969).

Research on the special feature/peculiarities of the deformation of rocks in focus range made it possible to determine its volume - $1 \cdot 10^{17}$ cm^3 (rock/species here underwent residual deformations), the approximate value of the relative shift of the wings of discontinuity 70 cm., which contributed to removal/taking elastic deformations at the torque/moment of the basic jerk/impulse; the average surplus elastic strain -60 kg/cm^2, removed during earthquake, and other values.

On the basis of the comparison of the values of the deformations of rocks during the main earthquake and its aftershocks, and also the deformation of the surface of the Earth, the conclusion is made that the Tashkent earthquake occurred as a result of the displacement/movement of rocks over the non-extended almost vertical fracture of northwestern strike/course, arrange/located in the prisvodovoy part of the Tashkent uplift/rise of Pritashkentskoy fold-disruptive zone.

End section.

Tectonic situation of the emergence of the earthquake on 26 April 1966.

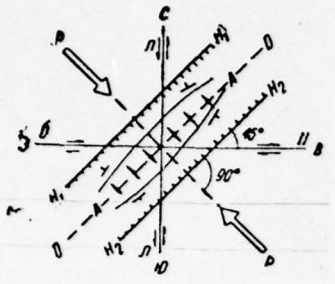
Alpine to skladchastot' in the eastern part of the Pritashkentskogo region, in spine/ridges Pskemskom, Ugamskom, Karzhantauskom others was expressed in shaping of the flat "folds of basis/base" in by the intensely rumpled and consolidated Hercynian motions thicker than paleozoic sedimentary, magmatic and metamorphic rock, the "folds of covering" in the sedimentary rocks of Mesozoic and cainozoic age and sufficient to the complex grid/network of different type tectonic discontinuities, but with the predominance of the longitudinal overthrusts, separate/liberating the newest tectonic depression from uplift/rises with incidence/drop to the side of the latter. Folds and discontinuities stretch themselves predominantly in north-east-south-western direction. A similar system of strains it is possible to explain by the presence of the field of tangential tectonic stresses, perpendicular to the axes of folds and discontinuities.

Under conditions of the horizontal compression of this direction in thicker than the rock/species of crust can arise the discontinuities, dissimilar in form, orientation and genesis.

First of all it is necessary to note the discontinuities whose formation is subordinated to the known law of shearing stresses.

These are the longitudinal nadvigi of north-east-south-western strike/course (longitudinal with respect to folds and transverse - to stress) with incidence/drop at an argle of 45-60° to the side relative to the elevated wings (according to the "rule of Leuksa"), and also the right and left diagonal shift/shears (right are the sublatitudinal strike/course, left - submeridional) with the abrupt/steep incidence/drop, close to vertical. Discontinuities of the type of diagonal shift/shears are encountered more rarely than the longitudinal nadvigi, but in certain cases they are exhibited extremely distinctly (Kopet-Dag). In the indicated system of the longitudinal and diagonal discontinuities, which are formed under the action of shears on the stress field of horizontal compression, there is no place to the discontinuities, parallel to the vector of stress, i.e., normal to the axes of folds.

However as show field observations and the calculation, in the process of the formation of fold itself appears one additional system of discontinuities - abrupt/steep is waste, upthrusts or the separations whose strike/course is normal to the axis of fold, and incidence/drop is close to vertical. Such discontinuities do not exceed the limits of fold and genetichesi are connected with the process of the bending of layer (not only in transverse, but also longitudinal direction). Typical examples of such folds with the dense grid/network of transverse abrupt/steep and short discontinuities in nuclei are known in the oil-bearing regions where are well studied exposed or revealed by boring anticlines (see Fig. (172).



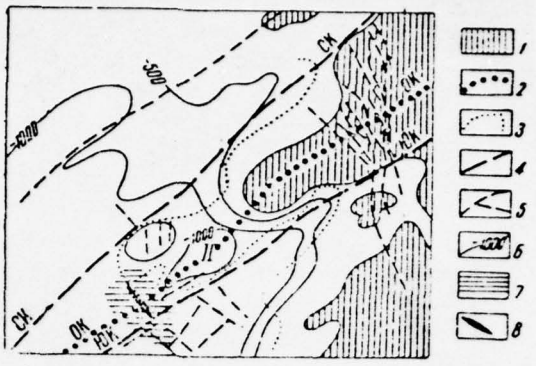


Fig. 172. Fig. 173.

Fig. 172. Schematic diagram of the emergence of plicated and fracture dislocations in plan/layout, under conditions of tangential compression (in accordance with the law of shearing stresses). P-P - compression stress; O-O - the axis of uplift/rise; A-A - is linear anticline (or moved away brachyanticline) with transverse vertical discontinuities. The longitudinal (with respect to the axis of uplift/rise), flat discontinuities northeastern are south-west rubbings and by incidence/drop of approximately 45°: H_1-H_2 is the overthrust with incidence/drop to southeast, which restricts uplift/rise from northwest; H_2-H_2 is the overthrust with incidence/drop to northwest, which restricts uplift/rise from southeast. The diagonal (with respect to stress P-P) abrupt/steep (incidence/drop is close to 90°) discontinuities: ⌐¬ is a left shift/shear of north-south strike/course; ⌐¬ - the right shift/shear of northeastern strike/course.

Fig. 173. Geotectonic situation of the emergence of Tashkent

earthquake. 1 - the exposed paleozoic masses, elevated as a result of Alpine folding; 2 - ~~SK~~, the axis of Karzhantauskogo uplift/rise (eastern part answers Karzhantauskomu spine/ridge, western - to its buried south-west continuation); 3. the boundary of the outcrops of Cretaceous and tertiary rock/species; 4 - longitudinal, comparatively flat, nadvigi (synthetic rubbers [СК] - north-karjantauskiĭ, YuK - southern-karjantauskiĭ); 5 - other tectonic discontinuities (chiefly, transverse); 6 - the isohypse of the surface of paleozoic basement (П - one-and-a-half uplift/rise); 7 - the epicentral zone of Tashkent earthquake and its aftershocks; 8 - discontinuity in the origin/hearth of Tashkent earthquake.

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The relative position of all enumerated disturbance/breakdowns is shown in Fig. 173.

In Pritashkentskom seismic region as an example the sufficiently complex "fold of basis/base" can serve the anticlinorium of Karzhantauskogo spine/ridge with its raised and exposed paleozoic nucleus and the longitudinal overthrusts among which are separate/liberated south and northern, separate/liberate uplift/rise from adjacent tectonic depression - Chirchikskcy and Kelesskoy.

The diagonal discontinuities of Alpine age are expressed here less vividly (Karachatauskiy sbrcso-shift/shear).

In the exposed part of the paleozcic nucleus to Karzhantau a zakartirovano large quantity also of transverse discontinuities. In essence they of Hercynian age, but on some are fixed shifts and in the Alpine stage of fold formation, for example, on Arashanskomu and Kumbel'skomu discontinuities.

Karzhantauskiy anticlinorium on meridian to Karachatau does not conclude, but while is submerged under the precipitation of mezckaynozoyskogo jacket, it stretches itself to south west to

Tashkert and further. This, can be judged from the following sign/criteria: the presence of the vast field of the outcrops of the Paleogere and neogene deposits, collected into folds and which stretch themselves from ridge/range to Karachatau almost to Tashkent; the configuration of the ischypses of the relief of paleozoic basement with the distinctly noticeable buried cape to the side of Tashkent (" the Karzhantauskaya line of uplift/rises", according to A. A. Aripov, M. A. Akhmedzhanov, to O. M. Borisov, to B. N. Ibragimov, to I. Fuzaylov, to D. Kh. Yakubov, see Fig. 124); the presence of the elongated in south-west direction one-and-a-half uplift/rise; configuration is izostrat in N. P. Vasilkovskiy's interpretation (1940) with the vividly outlined projection, directed to south west; the behavior of the roofing of neogene deposits and bottom of quaternary deposits (see Figs. 129 and 130, according to V. A. Zakharevich and A. I. Goncharenko); the amplitude of the relative strains of the surface of srednepleystotsenovoy (Tashkent) accumulative plain (see Fig. 136, according to K. O. Lange); geomorphological data (see Figs. 137 and 138, according to V. P. Mirchnicherko).

In the same south-west direction, being immersed under sedimentary cover, and partially also deforming it, pass the discontinuities, which border Karzhantauskiy spire/ridge from which south, according to data of regional geophysical studies, is located sufficiently confidently, but the presence northern on all sections thus far not is proved.

Other Alpine discontinuities of Western Tien Shan, in all likelihood, so pass far to south west along the submerged paleozoic basement and the deposits of sedimentary cover.

Thus, are all foundations for telling about the continuation of Alpine structure Karzhantau in the buried state to south west, to Tashkent and considerably further (Fig. 173).

The results of detailed seismic khissledovaniy showed following. The discontinuity, which served as the source of the earth shock on 26 April 1966, is oriented in northwestern direction (it is more precise, SZ [C3] - 230-240°). The field of the epicenters of iterative impulses is oval with long axis also northwestern - southeasterly directions (Ye. M. Butovskaya, A. I. Zakharov, I. M. Matasova, I. V. ~~Orange~~ (POMERANTSEVA), O. V. Sobolyev, V. I. Ulomov, N. V. Ulomova, N. V. Shebalin, L. S. Shumilin). The Smestitel' seysmogennogo discontinuity, connected with the basic jerk/impulse, and the focal zone of the origin/hearths of aftershocks as a whole are inclined toward northeast at an angle of approximately 75-80° (see Fig. 170), whereupon northeastern wing raised with respect to south-west.

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The origin/hearth of the main jerk/impulse lie/rested on depth of approximately 8 km near the bottom of paleozoic basement, but the

origin/hearths of iterative impulses were arrange/located in thicker than paleozoic rock/species, exceeding their limits neither downward, into the layer of "granite" nor upward, into sedimentary cover (Ye. M. Butovskaya, I. V. ~~Orange~~ Pomeranseva, V. I. Ulomov).

Thus, the focus zone of Tashkent earthquake and its aftershocks has direct coupling neither with the Tashkent section of Karzhantauskogo discontinuity nor with other known longitudinal or hypothetical diagonal discontinuities, but is connected with the system of transverse abrupt/steep discontinuities. As it was noted, the discontinuities, transverse to the axis of fold, appear as reaction to the stretching forces along axis, on one hand, and for the nonuniform vertical differentiated motions of the block/module/units for which turns out to be that which was broken the fold, on the other hand.

The emergence transverse, i.e., northwestern - southeasterly discontinuities is facilitated in this case by the fact that the strains of the layers of paleozoic basement, including ancient discontinuities, possess precisely northwestern - by southeasterly strike/course (according to N. B. Vol'fson and A. G. Khvalovskiy). The active role in the process of motion played the northeastern block/module/unit of focus zone to which was timed the base mass of the origin/hearths of iterative impulses. The uplift/rise of this block/module/unit was possible to fix by geodetic measurements (leveling) on surface within the limits of city (N. A. Koreshkov, A.

P. Bayzman).

Thus, the Tashkent earthquake on 26 April 1966 and its iterative impulses are caused by shifts of one of the block/module/units of the buried part of the Karzhantauskoye anticlinorium on the transverse to general strike/course of Alpine and newest structures abrupt/steep discontinuity northwestern - southeasterly strike/courses. The discontinuities of this type appear in folds in the process of their increase and are oriented perpendicular to the axis of fold, i.e., in parallel to the vector of the stress of the tangential stress field of compression. The plane of the smestitelya seysmogennogo discontinuity is deflected in this case from the vertical position (incidence/drop to northeast at an angle of 75-80°) that it is possible to explain by the common/general/total subsidence of the joint of the buried uplift/rise in south-west direction.

Under conditions of the noted above stress northwestern - southeasterly directions transverse to the common/general/total strike/course of plicated disturbance/breakdowns discontinuities of that type with which is connected Tashkent earthquake, must be considered in the common/general/total plan/layout for Alpine tectonics the strains of the secondary character. Primary meaning is retained after stretch deformations both plicated and disruptive. On this, they testify the suitability of the epicenters of the powerful earthquakes of Western Tien Shan to the zones of large longitudinal discontinuities (Gorshkov, 1966) and south-west orientation it

izoseyst powerful earthquakes (R. N. Ibragimov). In summation, is obtained the orthogonal system seysmogennykh disturbance/breakdowns, which is reflected, in particular, in configuration izoseyst Tashkent earthquake (A. A. Kon'kov, V. G. Rasskazovskiy et al.) and the location of the cracks, which were being observed on surface within the limits of city (M. A. Akhmedzhanov et al.).

To the longitudinal and transverse dislocation, fixed both on the surface and at depth, one should examine as the index of intensity and character of the motions of the Alpine and newest stages of fold formation.

~~Page 343.~~ The crystal part of the earth's crust is studied in this respect considerably weaker, but also in its limits they can be located seysmogennye dislocations and, therefore, seismic centers. As a result it is possible to consider that not only in Tashkent, but also in many other sections of Pritashkentskogo region, especially to the east from city, are possible powerful (to 8 balls) earthquakes.

After studying Tshekentskoye earthquake, we come to the conclusion that only when using the quite wide complex of the seismological, geological, geophysical, geodetic, geochemical, geomorphological and other methods of the study of the earth's crust in earthquake-hazard zones, in particular the geophysical methods of exploration, it is possible to obtain reliable results and to make reliable conclusions.

Pages 344 and 345 missing.

Page 346. Part III.

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Chapter I.

SEISMICITY AND THE SEISMIC DIVISION INTO DISTRICTS OF CENTRAL ASIA

SPATIAL DISTRIBUTION OF SEISMIC CENTERS.

Central Asia - one of the seysmoaktivnykh zones of the territory of the USSR. Is at present a series of the fundamental experiments in which is examined the question concerning the special feature/peculiarities of the distribution of seismic centers in space and time both in an entire territory of Central Asia and in its separate regions.

Central Asia includes regions with different geological structure and different seismicity.

The basic difficulty of research on the distribution of

seismicity in this territory is the instability of seismic mode/conditions.

The second difficulty during the generalization of observations of the earthquakes of Central Asia is connected with the heterogeneity of material in the different periods of time. So, to 1928 basic were makroseysmicheskiye data on powerful earthquakes - 8 balls and more; from 1928 on the basis of instrument/tool data it is possible to consider representative earthquakes with $M \geq 5$; from 1947 on 1951 - with $M \geq 4\ 1/2$; from 1952 on 1967 - with $M \geq 4$.

In this work during the generalization of seysmostaticheskikh data, we tried themselves all this to consider on the basis of available material were constructed 3 map/charts:

1. Map/chart of the epicenters of earthquakes with $M \geq 4\ 1/2$ ($K \geq 12$) for 1865-1967 (Fig. 174). For the reflection of impressiveness, the earthquakes of the different force, which occurred in the different periods of time, are divided into 3 groups: 1) 1865-1920 - makroseysmicheskiye data; 2) 1923-1951 - representative earthquakes with $M \geq 5$ - 4 1/2, the accuracy of the determination of epicenters, as a rule, is not higher than class Б (error is not more ±50 km) and 3) 1952-1967 - the representative zemletryaseniya s $M \geq 4$, epicenters within the limits of the territory of the USSR with the accuracy of class A (error does not exceed ±25 km) and outside the limits of the USSR - class В [6]. On the constructed thus map/chart it is possible to

judge not only the distribution of the epicenters of earthquakes, but also, to the certain degree, the stability of the seismic mode/conditions of different epicentral zones.

2. Compound map/chart izoseyst earthquakes by force in the epicenter of 7 balls and more (Fig. 175). For its composition are used not only makroseysmicheskiye data, but also the "theoretical izoseysty" which are constructed around instrument/tool epicenters and were determined magnitudoy earthquakes and by the geological structure of region (Is Report, 1962). This map/chart makes it possible to judge the destructive effect of the earthquakes of different epicentral zones.

3. Map/chart of the seismic activity A for 1956-1966 (Fig. 176).

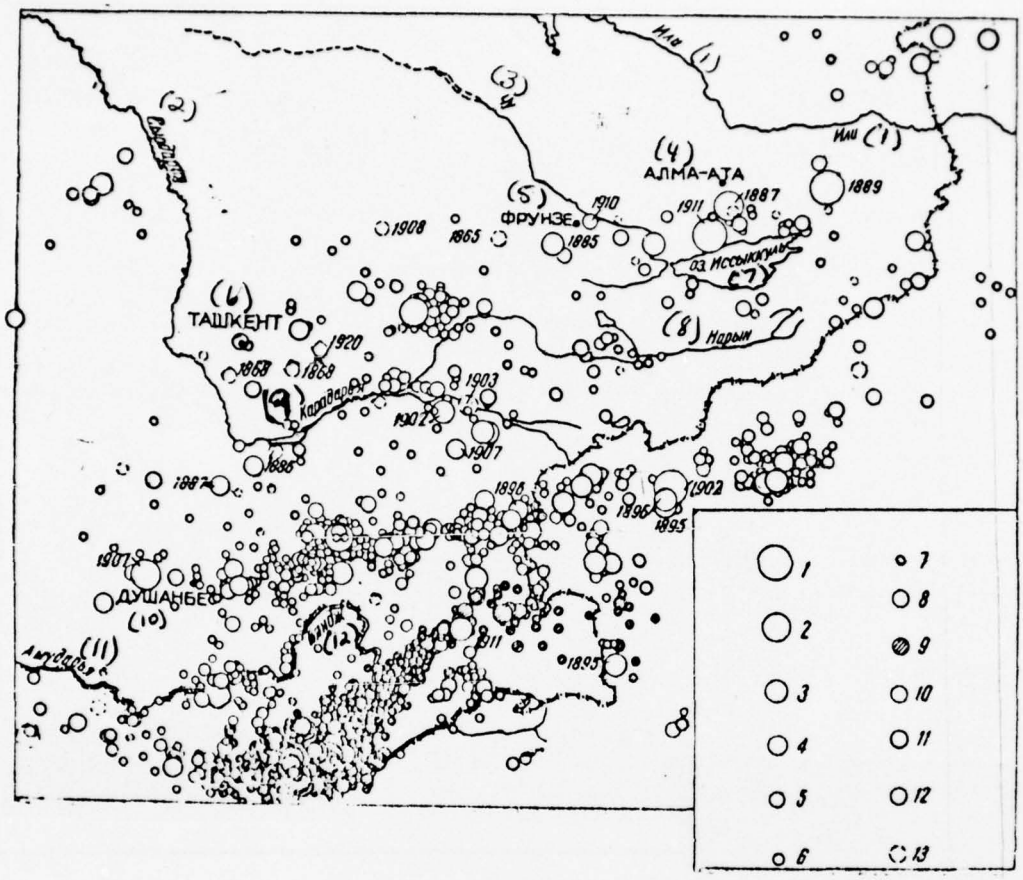

Fig. 174. The map/chart of the epicenters of the earthquakes of Central Asia for 1865-1966 (epicenters and magnitudy are determined by makrcseysmicheskim data). Scstavile N. A. Vvedsnskaya. Classification of earthquakes on the magritude: 1 - M > 8; 2 - 7 1/2 ≤ M ≤ 8; 3 - 6 1/2 ≤ M ≤ 7 1/4; 4 - 5 3/4 ≤ M ≤ 6 1/4; 5 - 5 1/4 ≤ M ≤ 5 1/3; 6 - 4 3/4 ≤ M ≤ 5; 7 - 4 1/4 ≤ M ≤ 4 1/2. Depth of the crigin/hearth: 8. in the earth's crust; 9 - under crust (50 km ≤ h ≤ 300 km). Time of earthquakes; 10 - 1923-1951; 11 - 1951-1966; 12 - 1865-1920; 13 - the error in the determinaticn cf epicenter can be mcre than 100 km.

[Key on following page.]

Key: (1). Or. (2). Syrdar'ya. (3). Chews. (4). Alma Ata. (5). Frunze. (6). Tashkent. (7). Issykkul'/ (8). Naryn. (9). Karadar'ya. (10). Dushanbe. (11). Amu-Dar'ya. (12). Illegible.

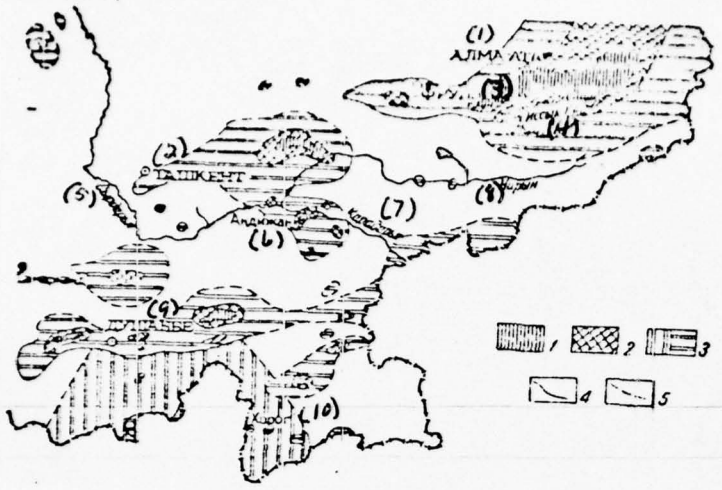

Fig. 175. Map/chart izoseyst destructive zemltryaseniy. The intensity of the jolts: 1 - 9-10 balls; 2 - 8 balls; 3 - 7 balls (a - - with subcortical zemltryaseniyakh, b - with origin/hearths in crust); 4 - outlines it izoseyst on the basis of data of examination/inspections; 5 - presumable outlines it izoseyst.

Key: (1). Alma Ata. (2). Tashkent. (3). Frunze. (4). Illegible. (5). Syrdar'ya. (6). Andizhan. (7). Karadar'ya. (8). Naryn. (9). Dushanbe. (10). Khorog.

For its construction are used the earthquakes with $K \geq 10$ during period from 1956 on 1966 with origin/hearths within the limits of the earth's crust. During this period the grid/network of seismic stations made it possible to record earthquakes with $K \geq 10$ with an entire territory of Central Asia without passages (with the exception of western regions).

The seismic activity $A = A_{10}$ is equal to the number of earthquakes with $K_0 = 10$ on area 1000 km² in 1 year. It was determined from the method of addition (Riznichenko, 1964 a) by the method of constant accuracy (Gorbunov, 1964).

For the construction of the map/chart of activity, the calculation of the template of averaging was performed on the basis of the total number of earthquakes, beginning with $K = 10$ and above, according to the formulas:

$$N_{10} = \frac{N_\Sigma (1 - 10^{-\gamma})}{10^{-\gamma (K - K_0)}} = \frac{N_\Sigma}{1{,}53}, \tag{1}$$

$$A = \frac{N_{10} \cdot 1000}{S \cdot T}. \tag{2}$$

Here N_Σ - the total number of zemletryaseiy; γ - the average/mean slope/inclination of the curve/graph of frequency for this region; T are a priod of observations; S - the area of region. In our case $N_\Sigma = 8$, which determined the accuracy of the construction of map/chart - 35o/o; $K_0 = 10$; $\gamma = 0.46$; T = 11 summers. The values

of activity on map/chart corresponded to the following area/sites of averaging:

A	S, км²	R, км
1	475	12
0,8	597	14
0,6	794	16
0,4	1256	20
0,2	2340	27
0,1	4825	39
0,08	6079	44
0,06	8263	51
0,04	11876	61

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Table 22. Characteristic of the basic seysmoaktivnykh zones of Central Asia.

(1) Зона	(2) Площадь в 10^3 км^2	γ	A_{10}	K_{max} за 1000 лет на 1000 км^2 (3)	(4) Наиболее сильное землетрясение зоны		
					K	I_{max}	(5) дата
(6) Средняя Азия в целом (очаг в земной коре)	713	0,49	0,2	15	—	—	
(7) Северный Тянь-Шань	69	0,48	0,09	14	18	9—10	12. VII 1889
(8) Нарын	90	0,52	0,10	14	14	7	3. XII 1954
(9) Южный Тянь-Шань	120	0,49	0,76	16	18	9	22. VIII 1902
(10) Чаткало-Ферганская	32	0,47	0,28	15	17	9—10	2. XI 1946
(11) Ферганская долина	14	0,55	0,54	15	16	9	16. XII 1902
(12) Туркестанский хребет	38	0 59	0,18	14	16	8	17. XI 1897

Key: (1). Zone. (2). Area into 10^3 Km^2. (3). K_{max} in 1000 summers on 1000 km^2. (4). The most powerful earthquake of zone. (5). date. (6). Central Asia as a whole (origin/hearth in the earth's crust). (7). Northern Tien Shan. (8). Naryn. (9). South Tien Shan. (10). Chatkalo-Ferganskaya. (11). Ferganskaya valley. (12). Turkestan spine/ridge.

The values of activity A were deposited to map/chart in the node/units of the square grid through 40 km on latitude and longitude, in the obtained field were carried out the isolines.

Thus, the map/chart of activity in essence reflects the distribution of epicenters relative to weak earthquakes with K = 10-11 for the latter 11 summers.

For the quantitative comparison of the seismic activity of different epicentral zones, are constructed the curve/graphs of frequency not only for entire Central Asia (Fig. 177), but also for separate seysmoaktivnykh zones (Fig. 178, Table 22). Relationship between M and K for the earthquakes of Central Asia the same as in works of V. I. Bune, N. A. Vvedenskoy, M. V. Gzovskogo (1968).

K	M
18	8
17	$7^1/_2-8$
16	$6^3/_4-7^1/_4$
15	$5^3/_4-6^1/_2$
14	$5^1/_4-5^1/_2$
13	$4^3/_4-5$
12	$4^1/_4-4^1/_2$
11	$3^3/_4-4$
10	$3^1/_4-3^1/_2$
9	$2^3/_4-3$

On the basis of the given map/charts and curve/graphs (Figs. 174, 178) it is possible to make following conclusions about the special feature/peculiarities of the location of seismic centers in the territory of Central Asia.

1. All earthquakes with origin/hearths under the earth's crust are arrange/located within the limits of the Pamiro-Gindukushskoy zone

which clearly is separate/liberated on all map/charts of the epicenters, constructed even during the brief period of time (year, month). This zone is characterized by stable mode/conditions and high seismic activity. For the latter 50 summers here it was isolated seismic energy more than for the same time in the entire territory in question in the limits of the earth's crust.

2. On the basis of the analysis of the detailed seismological observations which are carried out in many regions of Central Asia, established/installed that the large part of the earthquakes, in any case with $K \leq 12$, has a depth of origin/hearth from 5 to 15 km, considerably less part - 20-30 km, and only separate/individual earthquakes are noted at depth 30-40 km.

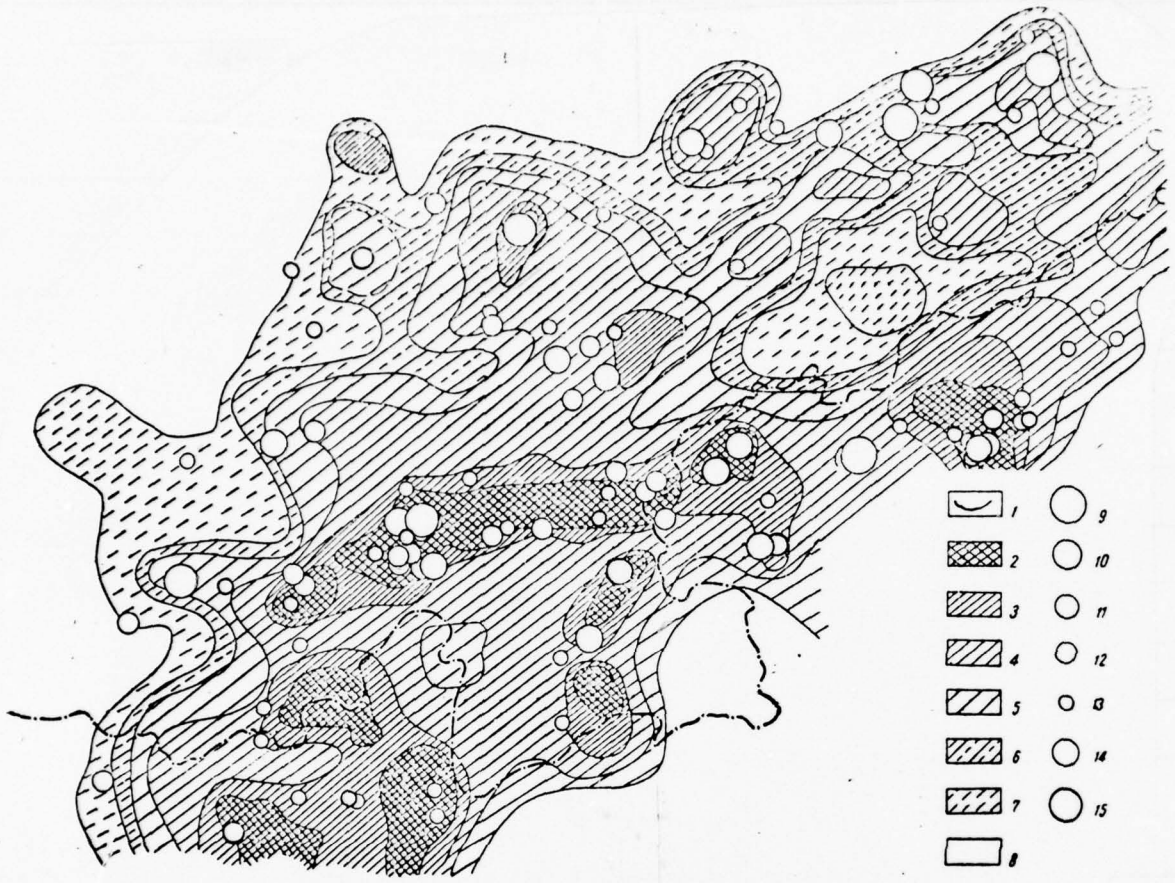

Fig. 176. Map/chart of the seysmichescy activity of Central Asia according to observations for 1956-1966 and the distribution of the epicenters of powerful earthquakes for 1885-1966. 1 - the iscline of the seismic activity A_{10}. Zones with different seismic activity; 2 - $A_{10} \geq 1.0$; 3 - $0.5 \leq A_{10} < 1.0$; 4 - $0.25 \leq A_{10} < 0.5$; 5 - $0.10 < A_{10} < 0.25$; 6 - $0.075 \leq A_{10} < 0.10$; 7 - $0.05 < A_{10} < 0.075$, 8 - $A_{10} < 0.05$. Classification of earthquakes on the energy classes: 9 - K = 18; 10 - K = 17; 11 - K = 16.; 12 - K = 15; 13 - K = 14. Time of the earthquakes: 14 - 1885-1956; 15 - 1956-1966.

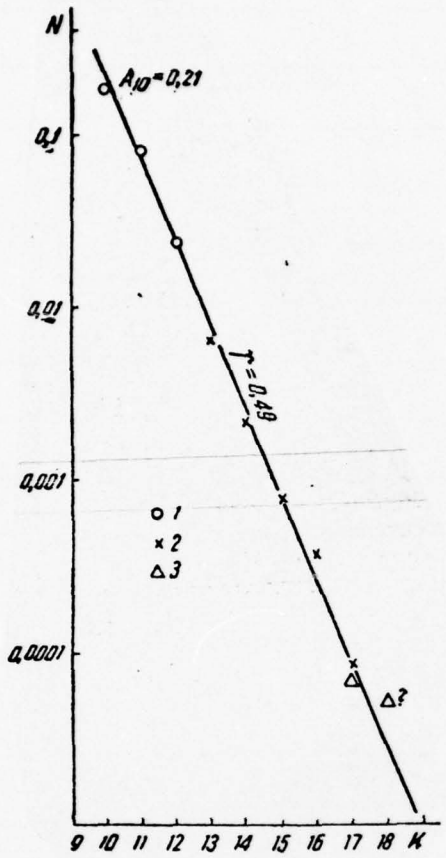

Fig. 177. Curve/graph of the frequency of the earthquakes of Central Asia. N is the average of earthquakes per annum on area 1000 km²; K - the energy class of earthquakes. 1 - frequency is determined by observations in 7 summers; 2. for 33 years, 3 - in 80-100 summers (sign of question noted those cases when the number of earthquakes, used to evaluate frequency, is bygone less than three).

3. The epicenters of earthquakes with origin/hearths in the earth's crust are arranged in the territory of Central Asia not disorderlyly, but in the form of the extended zones. Most definitely are separate/liberated two zones: north-t4n6wanska4 and southern-t4n6wanska4. Their location will agree well with the geological structure of region.

The north-t4n6wanska4 zone according to the number of powerful earthquakes and the character of their manifestation on surface is most active. Here at the end of XIX - beginning the XX explosive occurred two earthquake at K = 18, force of 9 balls and more, one at K = 17 and one at K = 16. Subsequently the activity of this zone was gradually decreased, into the latter 20 summers here is not noted earthquakes with $M \geq 4\ 1/2$. As is evident, for the north-t4nywansko1 zone $A_{10} = 0.09$ at the average/mean value for entire Central Asia $A_{10} = 0.2$. On the map/chart of activity for 1956-1966, the Severo-Tyanyshanskaya zone also is characterized by the lowered/reduced activity. During the investigated period (about 100 summers) the seismic activity of zone underwent considerable changes. Unfortunately, on the basis of the having available materials nothing it cannot be said about possibility and time of the new making more active of this region.

The southern-t4nywanska4 zone, especially its center section, is characterized by the constancy of mode/conditions. Throughout the investigated period, here occurred powerful earthquakes with K = 18; 17 and 16. At the same time during the average $A_{10} = 0.76$ regions of

the most active earthquakes - Kashgarskogo (1902) and Karatagskogo (1907) - on the map/chart of activity are characterized by relatively low activity A_{10} = 0.2-0.1. Vzomozhno, as in these regions we deal with a considerable reduction in the activity after powerful earthquake.

Remaining seismic zones are separate/liberated not so indisputably. Such earthquakes, as Tashkentskoyes (1966) and Kowtepinskoe (1965), can change sometimes hard edge. So, in work of V. I. Bune, N. A. Vvedenskoy and M. V. Gzovskogo (1968) into Chatkalo-Ferganskuyu zone are united the regions of Ferganskogo and Chatkal'skogo spine/ridges, heterogeneous according to the character of seismicity.

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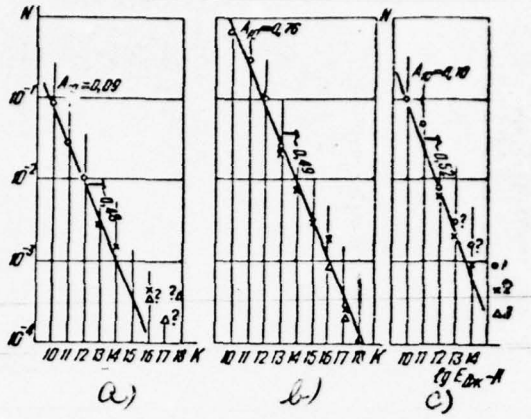

Fig. 178. Curve/graph tc pcvtoryaemoti for Severny (a) and scuth (b) Tien Shan and Narynskoy zcne (c) (ccnv. desiç. see in Fig. 177).

After the making more active of Pritashkentskogc region intc 1965-1966, it becomes clear, that here we deal with the separate zone, which passes as broad band from Tashkent tc the epicenter of Eskemskogc earthquake 1937, and the epicenter cf Chatkal'skogo earthquake lie/rests on the intersection of twc zones - Perganskcy and Pritashkentskcy.

Perganskaya zone (A_{10} = 0.54) confidently it is separate/liberated on the basis cf epicenters relative to the powerful earthquakes which were noted here thrcughcut the period of investigations. However, the distributicn cf the crigin/hearths of weak earthquakes nesoglasuyetsya with the distribution powerful: cn the map/chart of activity, this zcne in any way is not separate/liberated.

ISCIATICN OF THE BASIC SEYSMCAKTIVNYKh ZCNES ON THE BASIS OF SEISMOICGICAL AND TECTONIC DATA.

Historicc-tectonic zcning. The plains, which surround high-mcuntain Central Asia, in tectcnic relaticn are the platforms of different age. High-mountain part - the rarge cf activating tectcric mctions beginning with tertiary time, that is characterized by intense tectonic motions during the end cf the cligccere, neogen and quaternary period. The average for 30 summers the speed of these "newest" vertical motions is usually mcre than 100, frequently mcre than 150 meter per millicn cf summers. In newest time high-mcuntain part differs significantly from its surrcunding platforms. However,

in Paleogen and in the Mesozoic in Tien Shan of tale the same platform, but in Paleozoic period - the geosynclinal conditions as in the surrounding territories. Therefore the high-mountain part of Central Asia relate to the number of ranges the makings more active of tectonic motions in newest time.

The boundary of the region of making more active (Figs. 179, 22) proikhodit from south west to northeast, suppressing the southeasterly and latitudinal directions of the boundaries of more ancient tectonic zones. There does not exist at present the universally recognized principle of its conducting. It is indicated in the form of the conditional transition strip, depicted differently. However, the precision determination of this boundary has vital importance for a seismic division into districts. In this work as boundary, is accepted by pillar entire that chain/network of foothill basin/depressions, which separate/liberates mountainous region from its surrounding plains.

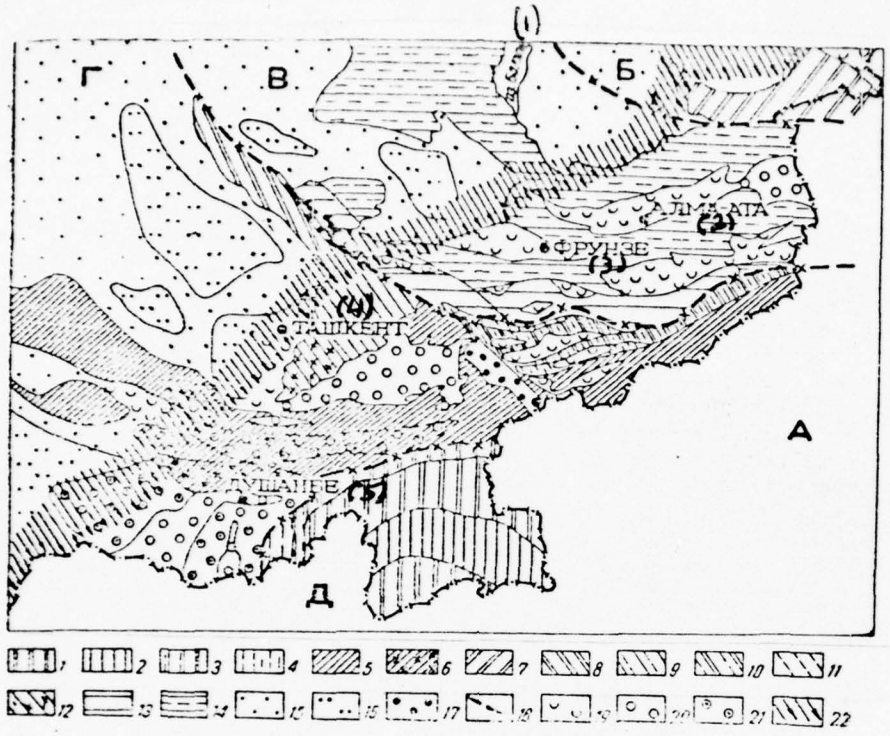

Fig. 179. Schematic tectonic map/chart of Central Asia. Comprised M. V. Gzovskiy. Geosynclinal range of Alpine stage. 1 - polimayushchiyesya neobrashchennye anticlinorium, which were being formed on the spot of intrageoanticline of the northern and south Pamirs; 2 - the being risen turned anticlinorium, which was being formed on the spot of the intrageosinklinali of the central Pamirs; 3 - the being risen part of the synclinorium of the Predpamirskogo foremost downwarp/trough, which was being formed on the spot of external intrageosinklinali; 4 - the being omitted part of the same synclinorium. Platform range of Alpine stage; 5 - the turned anticlinorium of the central uplift/rises of the south zones of Tien Shan; 6 - synclinorium of the internal basin/depression of the Gissarskoy zone of south Tien Shan; 7 - the turned anticlinorium of

northern part the Dzhungarskogo Alatau; 8 - the turned anticlinorium large Karatau in average/mean Tien Shan; 9 - the turned anticlinorium of the Chatkal'skoy zone of average/mean Tien Shan; 10 - the turned anticlinorium of the Narynskoy zone of average/mean Tien Shan; 11 - synclinorium of the foredeeps of average/mean Tien Shan in the basin of Naryna; 12 - synclinorium of the internal basin/depression of the Kuramirskoy zone of average/mean Tien Shan; 13 - neobrashchennye anticlinorium of the parageosinklinal'noy territory (in essence inherited from the turned Caledonian anticlinorium) in northern Tien Shan; 14. neobrashchennye synclinorium the pair of geosynclinal territory (superimposed to different Caledonian structural zones) in northern Tien Shan; 15 - the syneclise, which drop/omitted less than on 1000 m; 16 - drop/omitted is more than on 1000 m; 17. aulacogens tested considerable depression (to 3000 m) in different time (predominantly in Jurassic), then rising, everywhere strongly deformed; 18. the boundary of basic parts of the platform of Alpine stage, which have the basement: A) Precambrian (Tarim), B) Hercynian geosynclinal (Dzhungariya), C) Hercyniar parageosinklinal'nyy (northern Tien Shan, chew-iliyskie mountains, south part the Dzhungarskogo Alatau), D) Hercynian geosynclinal (average/mean and south Tien Shan), E) vneplatformennaya Alpine geosynclinal range. The range of activating tectonic motions, superimposed to different part one of two ranges (beginning with the end of the Paleogen): 19. the basin/depressions (synclinorium), strongly (it is more than 2000 m) which drop/omitted relative to adjacent zones during making more active on the places of syneclise, weakly (it is less than 1000 m)

drop/omitted in Mesozoic and Paleogen; 20 - basin/depression, strongly (are more than 3000 m) the drop/omitted during makings more active on the places of syneclise, strongly (are more than 1000 m) drop/omit in Mesozoic and palesgene; 21 - the new uplift/rises, which were being formed during making more active on the places of powerful (it is more than 1000 m) depression in Alpine stage (turred antitektorii); 22 - the external northwestern boundary of the region of making more active (within it all designations, except 4, 15, 16, 19-21 correspond to the different parts of the uplift/rise-antitektoriev).

Key: (1). Illegible. (2). Alma Ata. (3). Frunze. (4). Tashkent. (5) DUSHANBE.

The range of making more active is divided by three principal parts depending on that, for which more ancient tectonic conditions it was put making more active it corresponds to almost entire northern Tien Shan. Making more active was put here to the platform, which arose on the spot of the Hercynian parageosyncline, limited from south by V. A. Nikolaev's so-called line (zone C, Fig. 179).

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Center section lie/rests to the south (zone D[I]). Here, as in northern part, making more active occurred on the spot of Epihercynian platform. Platform replaced former here in the upper Paleozoic period completely of podvizhnug the geosynclinal range, which had complex internal structure. Therefore Mesozoic platform motions are relatively intense and diverse.

The south part of the range of making more active includes the Pamirs and the lying/horizontal to the south spire/ridges of Hindu Kush and Karakoruma (zone E[II], Fig. 179). Here in the past were not establish/installed platform mode/conditions, and geosynclinal conditions they were preserved, until now,. The south part is conditionally included also the eastern range of Tadzhik basin/depression, which converted in the Cenozoic into the foremost downwarp/trough of the Pamirs which in quaternary period began to experience/test the differentiated uplift/rise, in many places very intense.

Characteristic of the contemporary structure of the earth's crust according to geological, seismic and gravimetric data. The contemporary structure of the earth's crust of Central Asia is the complex system of the large plastic lumps, arrange/located at different height, which have different power/thickness and dissimilar laminar cross sections.

Each large lump consists of finer. The observing on discontinuity surface and strain are common for the different depth: some they depart deeply, up to the upper mantle, others reach the internal part of the crust, and the third seize only its upper layers. Are noted the discontinuities, which develop at depth, but still not come or surface, or in the past the developed at depth and ended their increase, not having reached the surface.

With seismic division into districts it is important to know, at which depth can be spread the discontinuities, observed in surface, which slope/inclination they have at depth, and also where can be developed the discontinuities, which do not emerge on surface. On the whole, for the newest disturbance/breakdowns of Central Asia are characteristic discontinuities and the strain, which are spread to considerable depth into the earth's crust. According to geological data, it is possible to trace them to gneisses and granites. According to seismic data, narrow anomalous zones are outlined to the bottom of crust, and on the Pamirs and in hindu kush - on 200 km inside mantle. Is noted the predominance of discontinuities with

abrupt/steep incidence/drop.

Tektonichesiye discontinuities during their development repeatedly heal - are filled with mineral substance, and then again they prerashchayutsya into the complex in form surfaces of the disturbance of continuity into zémncpy tc crust. The healed discontinuities frequently are cf their more durable surrounding rock/species. By no means all ancient discortinuities continue to be develcped ncw. The deep zcnes;cf discontinuities in Central Asia have a width to 15, but sometimes alsc 30 km and rot everywhere clear bcurdaries.

Isclatien ct zones with quasi-hcmogeneous seysmctektcnicheskimi ccnditicns.

The territory cf Central Asia is divided cr many sectiens (Fig. 180). Within each sectien the taktcnicheskiye ccnditions of the emergence of earthquakes in the first approximatien, are uniform. This means that the sectien ccnsists cf several fine fields of the determined types which are arranged sc tightly that to separate/liberate them cn map/chart with the given scale or with the existing degree of study, inexpediently.

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Shown in Fig. by 180 thick lines of boundary contour the sections within which the tectonic conditions of the emergence of earthquakes in the first approximation, are identical. This it indicates the uniformity of the history of ancient motions, which determined the structure of this section of crust, and the qualitative and quantitative characteristics of the newest motions.

To entire area of each section, is spread the identical estimation of its own seismic danger. The isolation of quasi-homogeneous sections on the basis of one tectonic data leads to the more test separation of territory, in comparison with the fact that is obtained during isolation on the basis of some seismological criteria. Since the seismicity is determined by a number of factors, several adjacent quasi-homogeneous sections are necessary to unite into one zone - the band of one category of seismic danger.

Isolation of zones on the basis of seismological and tectonic data.

Within the limits of Central Asia on comparatively general map (1:2500000) are separate/liberated the largest zones, connected with the basic tectonic structural cell/elements.

On the map/chart of seismic activity (Fig. 176) in 10 summers of observations, is well visible the most active southern-Tyan'shanskaya ~~tyanyanskaya~~ zone. With an increase in the period of observations and an accumulation, it is sufficient large volume of material all the seysmoaktivnye zones, outlined on the map/chart of epicenters, they must be clearly expressed, also, on the map/chart of seismic activity. With an insufficient quantity of epicenters, used for mapping of activity, on this map/chart occurs the merging/coalescence of different zones. Therefore conducting band edges (Fig. 180) is made on the basis of combined analysis of data on seismicity in the form of the map/chart of epicenters and tectonics. It is isolated 7 basic zones with the increased seismicity: north-Tyan'shanskaya, ~~tyanyanskaya~~, southern-Tyan'shanskaya ~~tyanyanskaya~~, Chatkalo-Ferganskaya, Narynskaya, Ferganskaya, Turkestan, Pamirskaya.

The boundaries of these zones, as a rule, were carried out so that each section quasi-homogeneous in tectonic relation, wholly would enter into any zone.

TAB probably it is possible to consider that the delineation of zones sufficiently is reliable wher they are divided by sections with the

low activity of the weak earthquakes on which in the past not of the bygone powerful earthquakes and which, furthermore, are isolated in tectonic relation. Such zones include the most dangerous: north-tyanyanskaya, southern-turkestanskaya, Chatkalo-Fergánskaya.

In certain cases of zone, insufficiently confidently they were separate/liberated also on the basis of seismological, and on the basis of tectonic data.

There are zones, which clearly are separate/liberated on the basis of seismological data, but they are not clearly isolated in tectonic relation, for example, zone, which is found in the east of the Ferganskoy spadiny between Namangan and Andizhanom. The detail of pursuance of research to scale 1:2500000 is insufficient for the isolation of the finer zones with which can be connected Tashkent type earthquakes.

FREQUENCY AND MAXIMUM ENERGY OF EARTHQUAKES.

Frequency of earthquakes. Entire territory of Central Asia is characterized by values γ = 0.49, A_{10} = 0.2 for earthquakes with origin/hearths in the earth's crust. In accordance with these values, here yearly occurs on the average one earthquake with K = 14, i.e., approximately with the energy of the Tashkent earthquake on 26 April 1966 (K = 13.5).

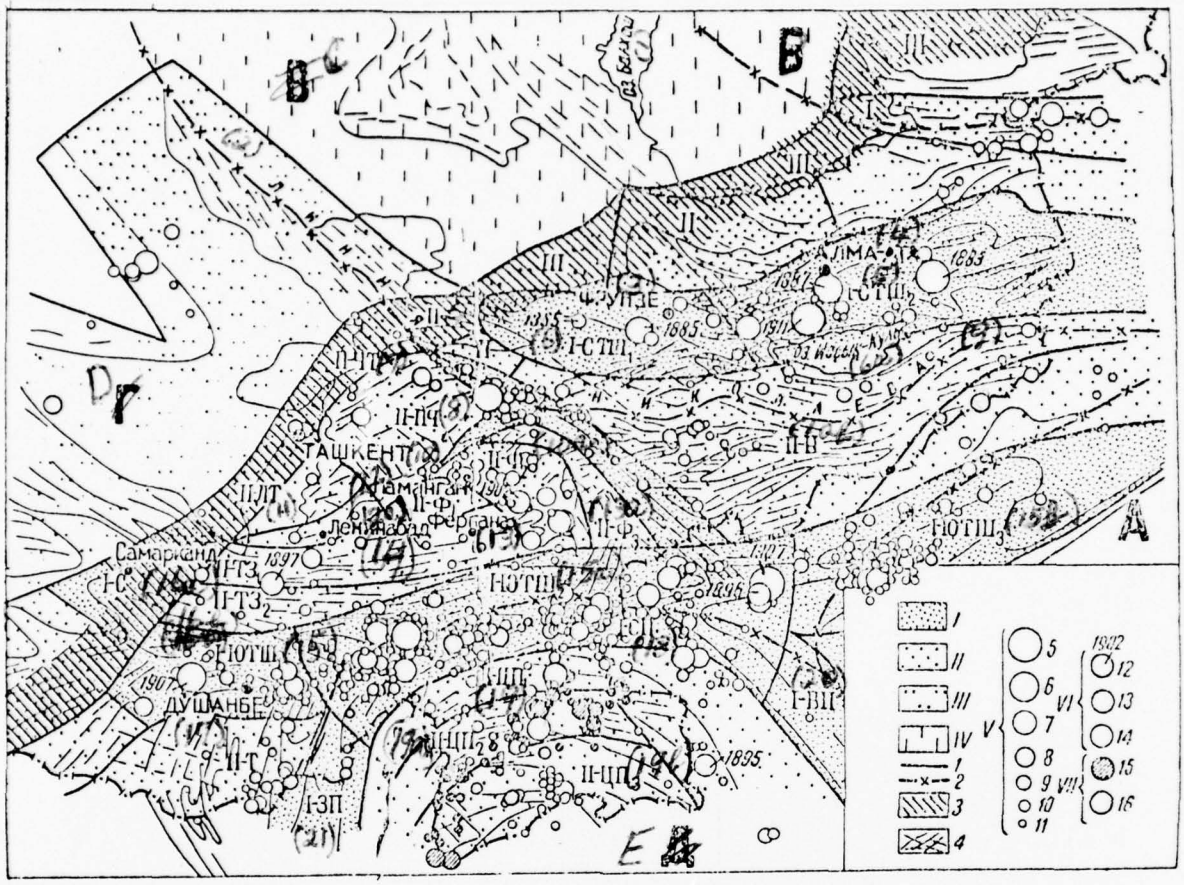

Fig. 180. Diagram of the estimation of the seismic danger of Central Asia according to the complex of tectonophysical criteria and the epicenters of all korovykh earthquakes with $M \geq 4$ ($K \geq 12$), recorded for 1865-1967. Geological-tectonic data. I - the bands of I category; II - band are II category; III - band III category; IV - band IV category 1 are graniy of sections, quasi-homogeneous in by seysmotektonichesom relation; 2 - the boundary of tectonic ranges and their large parts; 3 - the northwestern edge of the range of activating tectonic motions; 4 - the boundary of the particular

tectonic zones, the strike/course of folds and discontinuities. Seismological data: I - classification on the energy classes: 5 - K = 18; 6 - K = 17; 7 - K = 16; 8 - K = 15; 9 - K = 14; 10 - K = 13; 11 - K = 12; VI is a classification on the accuracy: classes A (±25 km) and B (±50 km): 12 - in period of 1865-1911; 13 - in period of 1956-1966; 14 - neklassnye. VII is a depth of seismic centers: 15 - subcortical; 16 - korovykh.

Key: (1). Lake balkhash. (2). Lines. (3). Frunze. (4). Alma Ata. (5). I-STW$_2$. (6). I-STh$_1$. (6a). Lake issyk-bag. (7). II-CT. (8). II-PC. (9). Nikolaeva. (10). Tashkent. (10a) and (10b). Illegible. (11). II-LT. (12). Namangan. (12a). Illegible. (13). Fergana. (13a). II-P$_3$. (14). Leninabad. (15). I-HTW$_2$. (15a). I-HTW$_3$. (16). Samarkand. (16a). II-TZ$_1$. (16b). II-TZ$_2$. (17). Dushanbe. (18). I-ethyl alcohol. (19). II-QP$_1$. (19a). II-QP$_2$. (19b). II-QP$_3$. (20). I-vp. (21). I-zp.

For northern Tien Shan (Fig. 178) points for earthquakes with K = 16-18 for 33 years and in 80 summers are not placed to one straight line with weak earthquakes with K = 10-12 for the latter 7 summers, what indicates the possible change of the seismic mode/conditions - weakening 3 times of seismic activity in recent years. It is necessary to speak about the possible change in the mode/conditions, since the number of powerful earthquakes in 30-80 summers in to this zone insufficiently is great in order that this conclusion/derivation possible bygone statistically strict to base.

Maximum energy of earthquakes. The greatest difficulties consist of the determination of the upper limit of the energy of possible earthquakes K_{max} and with respect to maximum irtensity J_{max} for each zone. The method which most frequently is applied at present, entails the fact that the earthquake of greatest veichiny $K = K_{max}$, recorded in one place within the limits of zone, is considered possible in any place on an entire area of zone.

New ideas about the estimation of maximum possible earthquakes K_{max} on the basis of their correlation with the average/mean seismic activity in the surrounding range are expressed to Yu. V. Riznichenko (1964 b, 1966 a, b) and are used in the works of other authors (Gorbunov, 1969; Zakhorova and Seyduzova, 1969).

Dependence between A and K_{max}. On the basis of the map/chart

of activity, we made a new polytku to establish/install the correlation between the average/mean seismic activity of sections and the maximum earthquakes which on them occurred.

Urlike Yu. V. Riznichenko, we assumed that area S, "critical" for the preparation of earthquake, does not depend on its value (S everywhere identical).

For the vyyaleniya of unknown communication/connection to the map/chart of activity, are plotted/applied all powerful earthquakes beginning from 1885 and the earthquakes of the average/mean classes of energy for the latter 37 summers (from 1929, the atlas of the earthquakes of the USSR, 1962). Transition from M and K is made according to formula T. G. Rautian (1960): $K = 4 + 1.8M$. We conditionally considered that activity A, obtained from observations during 11-summer period (1956-1966), was bygone the same as in period of 1885-1955. Correlation dependence they searched for between the average/mean activity A on the pads 1600 km² in size/dimension and the value of the earthquakes which after these area/sites of tale maximum. It was assumed (Riznichenko, 1966 a) that on the correlation curve/graph A, K_{max} the maximum observed earthquakes can be located in the points of that range of the correlation field A, K_{max}, which lie/rests more left and higher than the line of the maximum possible earthquakes (Fig. 181).

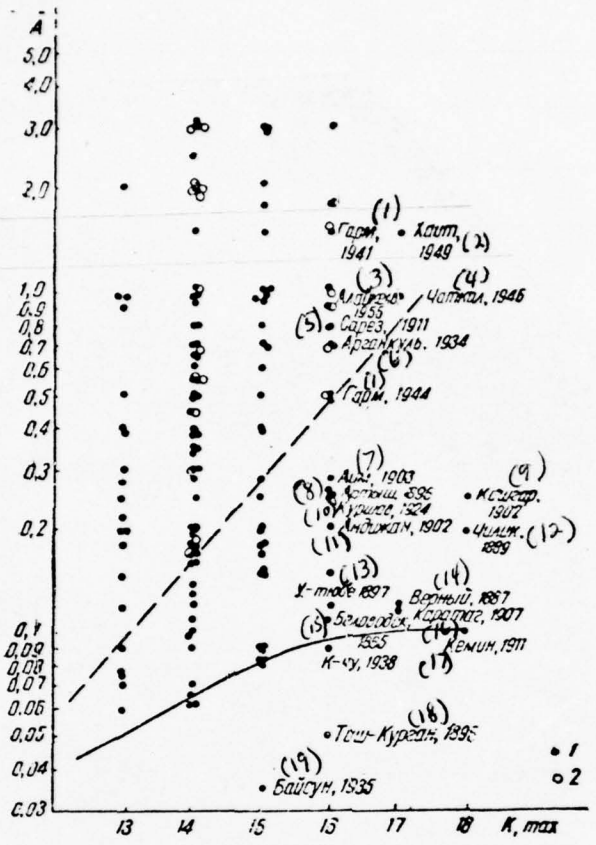

Fig. 181. Graph/diagram of the dependence between A and K_{max}. 1 - the earthquakes which occurred to 1956; 2 - afterward 1956.

Key: (1). Garm. (2). It Khait. (3). Illegible. (4). Chatkal. (5). Sarez. (6). Argankul'. (7). Aim. (8). Artyshch. (9). Kcshgar. (10). Kurshav. (11). Ardizhar. (12). Chiaik. (13). to at-tbbe. (14). Accurate. (15). Belovcdsk. (16). Karatag. (17). Kemin. (18). Tash-Kurean. (19). Baysun.

This line composes, thus, lower boundary of the region, filled by the observed points (A, K_{max}). To it corresponds the following equation: $\lg AK_{max} = -1{,}319 + 0{,}14\ (K_{max} - 13) - 0{,}014\ (K_{max} - 13)^2$.

From the figure one can see that the obtained by us with S = const graph/diagram of the dependence between A and K_{max} is bent in the range of the earthquakes of the high classes of energy. In the case of S = var (Riznichenko, 1964 a, 1966 b) this does not occur.

When using our procedure for correlation with S = const for the regions of Central Asia, the earthquakes with great to significance $K_{max} = 15-18$ correspond to the lower (and besides to almost identical) level of activity, than this should be expected, on the strength of the approximately straight portion of the curve/graph, corresponding to the earthquakes of the lower classes of energy $K_{max} = 10-14$. Judging by the curvature of curve/graph, powerful earthquakes can occur in the local range not of highest contemporary activity, but where this activity not lower than defined level, which appears as the lower limit during which the powerful earthquakes are still possible.

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However it is possible to assume that a decrease in the activity, for example on northern Tien Shan, bears local and time/temporary character and it occurred because of the discharge of the stressed state of the earth's crust in range five of strongest earthquakes, which occurred in the beginning of century.

The correlation dependence between the activity, determined in 11 summers, and maximum earthquakes for this period has a different form (Fig. 181). Strong earthquakes for the latter 11 summers are plotted/applied by empty small circles. To them corresponds line of demarcation for the maximum possible earthquakes, the shown broken straight line. It is interesting that this straight line is approximately parallel to the curve/graph, obtained by Yu. V. Riznichenko (1964 a, 1966 a, b) for other regions (continuous straight line in Fig. 181). In this case, the straight line Riznichenko has ordinate A, the same as our curve in the range approximately of those values K_{max} where the size/dimensions of our ranges S = const the same as size/dimensions of S = var, used Yu. V. Riznichenko.

To make any conclusions on the basis of this material thus far early, since used by us the period of observations (11 summers) for determining activity is small and much less than the period of the frequency of the earthquakes of the high classes of energy, plotted/applied to curve/graph as the maximum in the range three orders of energy K = 14-16. So, on area S = 1600 km² in the most active region - south Tien Shan, where A = 0.76, the repetition period of earthquakes K = 14 is 6 summers, and for K = 16-60 summers; in northern Tien Shan, where A = 0.09, for K = 14-60 summers and for K = 16-600 summers.

From correlation (Fig. 181) it is evident that the earthquakes at K = 16-18 occurred in seismic zones at activity 0.095 and above, at

K= 15->0.080, at K = 14->0.065.

When conducting this analysis data on seismicity for the latter 11 summers on the pads 1600 km² in size/dimension we conditionally ascribed to period into 100 summers. Between the fact, it is possible that on such comparatively small pads the parameters of seismicity can strongly change. So, it is possible that γ can prove to be more either less than the lasting average value by 1/3, but A - 2-3 times more or less than the average. On the larger areas of a variation in the syesmichnosti, they must be less.

Apparently, during historical period only on the small part of Central Asia had time to be revealed the earthquakes of really/actually maximum possible value K_{max}. The used above method of correlation K_{max} with A with S = const = 1600 km² the y'Ovydeleniya of zones with different values K_{max}, obviously, is insufficient for the successful solution of this problem, especially for large earthquakes with $K_{max} = 15-18$.

CRITERIA FOR SEISMIC DANGER ACCORDING TO TECTONIC DATA.

The most important representations, which lie at the principle of the estimation of seismic danger according to tectonic data, consist of the following.

Danger depends on the totality of a number of factors; the

mechanism of speed and history of strain, extent of the zone, encompass by strain. On these factors it is possible to judge the basic physical conditions of the emergence of earthquakes, the stress level in the region of origin/hearth, the elastic and strength properties of medium in origin/hearth, the volume of origin/hearth and, in summation,, a possible quantity of potential energy, which is powerful to be isolated from origin/hearth.

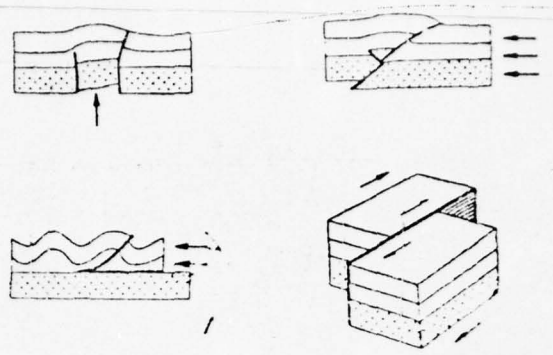

Fig. 182. The diagrams of the contemporary strain of crust, utilized by researchers of the different regions of Central Asia (thick line - discontinuities, the thick rifleman/gunrers are active usliya).

Furthermore, the emergence of earthquakes affects insufficiently known to us nonuniformity of the stressed state of crust in time the extent/elongation of the centuries for which is given estimation of danger. To us little known about differences of the physical properties of medium in seismic centers in different regions. Therefore it is obvious that communication/connection between the totality of tectonic factors considered and the seismicity in principle cannot be functional, i.e., the strictly unequivocal. This communication/connection exists as correlation, previously allow/assuming some deviations from the predominant relationships.

Thus, all the estimations of danger according to tectonic data must be considered as probabilistic. The establishment of the coefficients of the correlation of the totality of tectonic criteria with seismicity, the determination of the probability of estimations and their truth values, i.e., the quantitatively expressed authenticity, are the most important problem of the nearest investigations.

Let us pause at the indicated evaluation criteria of seismic danger according to tectonic data.

four type of the mechanism of the contemporary strain of crust. Strains of crust, connected with the action of vertical forces (Figs. 182, I). By this diagram most stressed and dangerous in seismic relation are considered the bands within which pass the steeply falling/incident deep zones of discontinuities. Here must be recorded

the greatest values of the gradients of the speed of vertical tectonic motions. The main discontinuities are the upthrusts which only by places are converted in nadvigi.

Strains of the earth's crust under the action of horizontal forces of compression. In this case large discontinuities in Central Asia are considered as nadvigi and upthrusts. Are allow/assumed the considerable (dozen kilometers) amplitudes of horizontal drift on the flat overthrusts transversely of their strike/course (Fig. 182, II). The epicenters of earthquakes are expected ir this case in the places, strongly moved away from the outcrop of overthrust to surface.

Late these predstavleniya obtained two sigrificant supplements.

Wide development in the sedimentary covering of the considerable strains, disharmonic with respect to paleozoic basement.

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In this case (Fig. 182, III) between the gradient of the speed of vertical motions on surface and the distribution of origin/hearths in deep parts of the earth's crust there is no communication/connection.

Concept about the existence into Central Asia of very large horizontal shift displacement on 100-200 km along the strike/course of some deep zones of discontinuities (Fig. 182, IV). Shift/shears

predominantly are considered the discontinuities of the northwestern strike/course for which the characteristically right-hand direction of displacement. As the greatest shift/shear in Central Asia, is indicated Talaso-Fergansk iy, passing along the northeastern slope of Fergansk ogo spine/ridge. On the basis of the horizontal-shift diagram of the strains, given on the gradient of the speed of vertical motions one should consider insufficient to evaluate seysmichesoy danger.

Of all proposed diagrams of the strain of the earth's crust into newest and especially in quaternary time, apparently, most corresponds to facts diagram I (Fig. 182), in which the main role play vertical forces. Therefore it is utilized subsequently as basic, but is examined only as first approximation. This diagram requires considerable modification in the future.

The value of the gradient of the velocity of the newest tectonic motions of the rate of the strain of crust was calculated in some regions of Central Asia as the average for the last/latter 30-40 million summers only for a vertical component. This only possible now characteristic of the velocity gradient of velocity is too common/general/total. In a series of places, the proceeding motions are considered insufficiently.

The survey diagram of the gradient of the rate of the newest motions in Central Asia not in all its parts is equally based and requires further refinements (Fig. 183). From it it follows that

approximately to 75c/o cf area of the high-mcuntain part of Central Asia gradient [redacted] velocity is greater than $1 \cdot 10^{-9}$ year^{-1}. The greatest values of the gradient correspond to the deep zcnes cf discontinuities. Ey tracing such zones beycnd the limits cf the range of making more active, it is possible tc see that the velccity gradient of velccity in them very it is strong (10 times and mcre) it decreases about the bcundary of the region of making more active. Ccnsequently, the same zcnes cf discontinuities within the limits cf platform are less dangercus in seismic relaticn, than in the range of making more active.

Within the range of making more active it is possible tc isclate several types of large zcnes. Ir first type zcres almost on their entire area is state/established the high value cf the velocity gradient of velocity ($3 \cdot 10^{-9}$ and $1 \cdot 10^{-8}$ gcd^{-1}). For example such zcnes is drawn from Alma Ata to Frunze alcng the ncrthern bcrder of Tien Shan with platform, along the south bcrder cf Tien Shan frcm Dushanbe through the Alayskuyu valley intc Aksu; the third zone surrcunds the Pamirs frcm ncrthwest, ncrth and ncrtheast.

In seccnd type large zcnes considerable area cccupy the sectiens with the low values cf gradient ($3 \cdot 10^{-9}$ and $1 \cdot 10^{-9}$ gcd^{-1}). The internal structure of these zcnes variegated, they consist cf numercus small sections with the different value cf gradient (for example Turkestanc-Zarafshanskiye mcuntains, Eskemskc-Chatkal'skiye mcurtains, Narynskaya basin/depression, Ferganskaya basin/depression, etc.). The less weighted mean value cf gradiert in seccrd type bands makes them

on the whole seismic less dangerous, than first type bands.

Subsequently on the basis of the measurements of the heights of terraces, is necessary research on the velocity gradient of velocity, average/mean for a quaternary period and its epochs, and also determination by the geodetic methods of the velocity gradient of velocity for the time intervals, measured for years and by decades.

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On the basis of data on the velocity gradient of velocity, will be obtained the reliable information about seismic danger (Gzovskiy, the Nikons, 1968).

Besides the velocity gradient of velocity, which everywhere does not succeed in measuring, one should know an additional two values, which make similar physical sense. This is the difference in the maximum speeds of the motion of adjacent tectonic zones (lumps) and the rate of growth of the amplitude of discontinuities. Each of these two values indirectly characterizes the gradient of the rate of motions, i.e., the deformation rate of deformation and the connected with it value of shearing stresses in the earth's crust. In first type, zones difference in the average maximum speeds for 30-40 million summers reaches to 200 meters per million summers. The amplitude of displacement on the majority of discontinuities for newest time usually more than 5 km, sometimes reaches 7-9 km. In second type,

zones difference in the maximum speeds is usually less - 100 meter per million of summers. The amplitude of displacement on discontinuities for newest time is 1 km or less (it is rare 3-4 km).

The separation of large zones into two types is conducted on a series of the approximate quantitative criteria. Is noted the large danger of first type zone in comparison with second type zones.

History of the strain of crust. The irdividual characteristics of the history of strain and structure of each zone do not find expression on the map/chart of the gradient of speed (Fig. 183), i.e., they are insufficient to evaluate seismic danger.

North-t4nywanska4 zone (see Fig. 180, I-STW) it differs in terms of the almost constant duty of motions. Here the sign and the average value of gradient virtually do not change during prolonged period of time.

The southern-t4r6wanska4 zone (I-HTW) [I-ЮТШ] is characterized by the large inconstancy of the sign of gradient in space and time on its common/general/total high level. Therefore the existing within it sections with not the very high value of gradient are seismic very dangerous. The real contemporary value of gradient can be considerably higher than the average.

Chatkalo-Ferganskaya zone (I-~~ct~~) [ЧФ I-4Ф] differs in terms of the

alternation of sections with the sharply different value of the gradient of the speed of vertical motions, the reliable sign/criteria of recent shift displacement into horizontal direction along the strike/course of zone and an especially wide development of discontinuities, which intersect it across or obliquely. All this increases the seismic danger of this zone in comparison with the danger, evaluated in one average value of the velocity gradient of velocity.

The greater the change in strike/course, sign and the deformation rate of deformation, the higher seismic danger of territory.

Value of tectonic zones with the homogeneous deformation of crust. In first type zones narrow belt/zones with the uniform conditions of strain is drawn on 100-200 km (I-STW, I-HTW). In Chatkalo-Ferganskoy zone the uniformity of the conditions is retained in extent/elongation 10-50 km, in Tadzhik, Ferganskoy and Narynskoy - less than 100 km, in Turkestano-Zaratshanskoy - about 100 km.

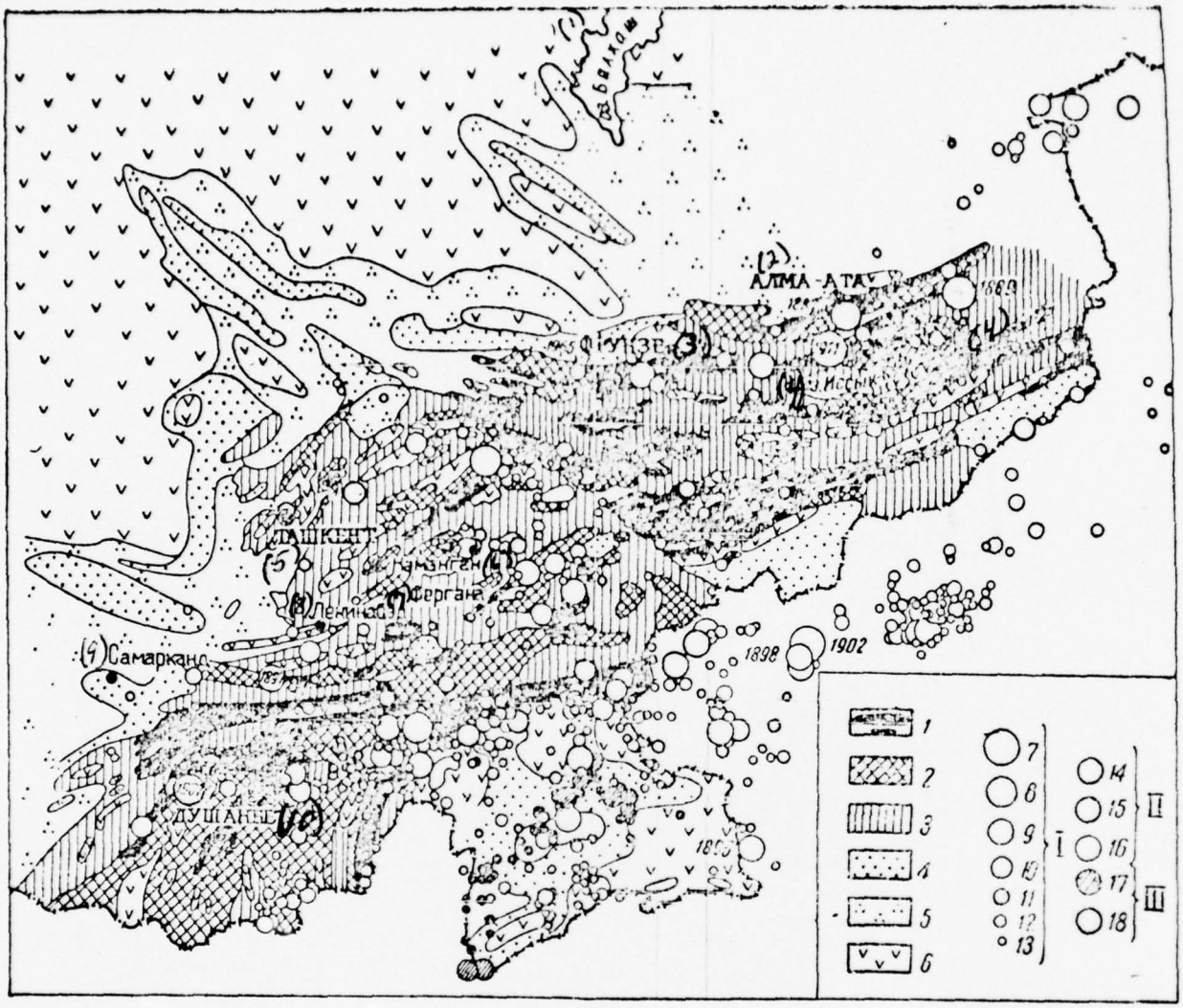

Fig. 183. The comparison of the diagram of the gradients of the average speed of vertical tectonic movements for newest time (comprised B. N. Nikolaev) with the map/chart of the epicenters of earthquakes. Value of the gradient: 1 - $1 \cdot 10^{-8}$ god^{-1} and more; 2 - from $3 \cdot 10^{-9}$ to $1 \cdot 10^{-8}$ god^{-1}; 3 - from $1 \cdot 10^{-9}$ to $3 \cdot 10^{-9}$ god^{-1}; 4 - from $3 \cdot 10^{-10}$ to $1 \cdot 10^{-9}$ god^{-1}; 5 - from $1 \cdot 10^{-10}$ to $3 \cdot 10^{-10}$ god^{-1}; 6 - less $1 \cdot 10^{-10}$ (seismological data the same as in Fig. 180).

Key: (1). Lake balkhash. (2). Alma Ata. (3). Frunze. (4). Lake issyk-kag. (5). Tashkent. (6). Namarçan. (7). Fergana. (8). Ieninabad. (9). Samarkand. (10). Dushanbe.

An increase in the size/dimensions of zones with the constant conditions of the strain of crust is the sign/criterion of the intensification of seismic danger.

Bands of the first category. The high values of the velocity gradient of velocity almost are everywhere more $1 \cdot 10^{-9}$ god^{-1}. Numerous contemporary discontinuities cut here entire earth's crust. The length of many of them is measured by hundreds of kilometers. The amplitudes of displacement/movement over discontinuities in neogen-quaternary time reach to 7-9 km. High tectonic to podvizhnot' was preserved also in contemporary epoch (latter 10,000 summers). Uniform conditions are observed in bands by the width of dozen kilometers (sometimes to 150 km) and by length 1000 km and more.

All bands of the first category must enter into the zone of the seismic danger of zemletryaseniy with $K_{max} = 18-17$, since in many sections of the first category occurred such earthquakes.

Bands of the second category. The qualitative difference in sections and their uniting bands of the second category is the fact that they pass along the boundaries of the structural elements of the crust of lower order, than the sections and the bands of the first category. Respectively, the extent of sections and bands of the second category approximately is twice as short, but width is considerably less. It is assumed that and the penetration of these

bands at depth is also less than of the first category. The amplitude of the relative displacement of the structural elements of crust, divided by the sections of the second category, time into two is less than of those which were divided by the bands of the first category.

In summation, it is possible that the frequency of catastrophical earthquakes in the bands of the second category at least 2-4 times lower than in the bands of the first category, and can comprise to one earthquake into 10^3 summers on area 1000 km^2. In principle, the emergence in the bands of the second category of earthquakes with K = 17 is possible.

The bands of the second category on the average must correspond to zone with $K_{max} = 16-15$, since it is assumed that the frequency of earthquakes with K = 17 in them is is very low.

Bands of the third category. The predominant value of the velocity gradient of velocity is considerably less than in the bands of the first and second categories - from $1 \cdot 10^{-9}$ to $3 \cdot 10^{-10}$ god^{-1}. Discontinuities reach length less than 100 km. The amplitude of the newest displacement/movements over discontinuities is usually less than 1 km and only rarely 1-2 km. Extent of quasi-homogeneous sections 100-200 km. The bands of the third category are included sections, which are located mainly on the periphery of the range of making more active where the transition from it to platform range along the postiraniya of tectonic zonality is more or is less

gradual. On the northern border of Tien Shan, the transition from the range of making more active to platform is realized sharply and transversely the strike/course of tectonic zonality; therefore here the bands of the third category occupy less area.

On the map/charts of seismic division into districts, they on the average must correspond to zone with $K_{max} = 14$. However, in the region of Chiili in 1929, is recorded zemletryaseniye with K = 16.

Bands of the fourth category. The low value of the velocity gradient of velocity, is less $1 \cdot 10^{-10}$ cod^{-1}, and small amplitudes of displacement on discontinuities, in newest time rarely reaching to 500 m, are characteristic for the platform sections, moved away from the range of making more active. In such sections, which occupy vast area in the territory of the USSR, it is not recorded earthquakes with K > 12 (Table 23).

On the basis of sign/criteria, each section on the map/chart of Central Asia is related to one of the characterizable above categories. The sections, which obtained identical estimation, are fused into the overall seysmotektonicheskuyu band of one category (Fig. 180).

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Table 23. Characteristic of seysmotektonicheskikh sections and bands of different categories.

(2) Категория	(1) Тектонофизические характеристики				
	(3) градиенты скорости новейших движений		(4) частные зоны новейших разрывов		
	(5) максимальн., *град/год*	(6) обычный, *град/год*	(7) суммар. амплит., *км*	(8) длина по простиран., *км*	(9) ширина, *км*
I	$>1\cdot10^{-8}$	$3\cdot10^{-9}$	>5	>100	15—30
II	$>1\cdot10^{-8}$	$3\cdot10^{-9}$	<5	<100	10—20
III	$1\cdot10^{-8}$	$1\cdot10^{-9}$	<1 (редко(10) до 2)	<100	10
IV	$1\cdot10^{-9}$	$3\cdot10^{-10}$	≪1 (редко(10) до 0,5)	<100	10

(2) Категория	(11) Ожидаемые характеристики сейсмичности					
	(12) размеры полос и участков		(12a) максимальные		период повторяемости землетрясений (13)	
	(14) длина, *км*	(9) ширина, *км*	(15) магнитуда, M	(16) энергия, *дж*	K	T
I	≥1000	75—150	$>7^1/_2$	$>10^{15}$	15	10^2
II	<1000 >500	100—250	$\leqslant7^1/_2$	$\leqslant10^{15}$	15	10^3
III	<500	150—500	$\leqslant7^1/_2$	$\leqslant10^{15}$	15	10^4
IV	<500	150—500	$\leqslant4^1/_2$	$\leqslant10^{13}$	12	$<10^3$

Key: (1). Tectonophysical characteristics. (2). Categories. (3). the gradients of the speed of the newest motions. (4). the particular zones of the newest discontinuities. (5). is maximum. , grad/gcd. (6). usual, grad/god. (7). summar. amplitude, km. (8). length on prostiran., km. (9). width, km. (10). (it is rare to). (11). Expected characteristics of seismicity. (12). the size/dimensions of bands and sections. (12a). maximum. (13). the period of the frequency of earthquakes. (14). length, km. (15). magnituda, M. (16). energy, J.

The reliability of the position of the land edges of different category is not everywhere identical. It is determined by the degree of the contemporary study of geological structure and tectonics of the different regions of Central Asia and by the completeness of the quantitative characteristics of the newest and contemporary motions of the earth's crust. Significant nedostatkom is the absence of instrument/tool data on the contemporary vertical and gorizontal'nykh motions of the earth's crust.

SEISMIC DIVISION INTO DISTRICTS.

Estimation of the seismic danger of the zones of "its own" earthquakes. With seismic division into districts, besides K_{max} or M_{max}, is necessary the determination of the maximum intensity of jolts on surface J_{max}, since by the only characteristic of seismic danger is at present the maximum intensity of jolts. According to N. A. Vvedenskoy's data (1962), in Central Asia the jolts into 9 balls were observed during earthquakes from $K \geq 16$; 8 balls with $K \geq 15$ and 7 balls with $K \geq 13$. Thus, by knowing K_{max} for a zone, it is possible to evaluate J_{max} from "its own" earthquakes. When evaluating K_{max}, one should additionally consider the probable frequency of such events.

On the map/chart of the seismic division into districts of the USSR for the majority of zones, to ball'not' corresponds to the repetition period of earthquakes with K_{max} one time in 500-1500 summers per the unit of area of zone 1000 km² (Medvedev, 1968). In

accordance with this during determination K_{max} for a zone, let us consider the earthquakes, which proceed not thirrer than one times in 1000 summers taking into account unit of area 1000 km².

Table 24. Seismological and tectonic criteria for the isolation of zones with the different intersity of jolts with syesmicheskom division into districts.

(1) Зоны интенсивности на карте районирования	(2) Типы сочетания сейсмических и тектонических данных	(3) K_{max} для зоны за 1865—1968 гг.	(4) A_{10} на 1000 км² за 1 год	(5) K_{max} на 1000 км² за 1000 лет по графику повторяемости	(6) Категория полос по тектоническим данным	(7) Название зон на рис. 180
9	а	18	$0,05 < A_{10} < 0,3$	14	I	СТШ (8)
	б	18	$0,3 < A_{10} < 2,0$	16	I	ЮТШ (9)
	в	17	$0,5 < A_{10} < 1,0$	15	I	ЧФ (10)
	г	16	$0,2 < A_{10} < 0,5$	15	I	Ф
8	а	18	$A_{10} < 0,05$	14	I	Запад СТШ (11)
	б	16	$A_{10} < 0.3$	14	II	Юго-вост. П (12)
	в	14	$A_{10} < 0,3$	?	II	Восток Т (13)
	г	14	$A_{10} < 0,3$	14	I—II	Н
7	а	16—13	$A_{10} < 0\ 05$	?	IV	Чиили (14)
	б	14	$A_{10} < 0,3$	?	II	Запад Т (15)

Key: (1). Zones of intensity on the map/chart of division into districts. (2). Types of the combination of seymicheskikh and tectonic data. (3). K_{max} for a zone for 1865-1968. (4). A_{10} on 1000 km² for 1 year. (5). K_{max} on 1000 km² in 1000 summers on the curve/graph of frequency. (6). Category of bands according to tectonic data. (7). Name of zones in Fig. 180. (8). ST Sh. (9). ~~YuTSh~~ ~~HTw.~~ (10). ChF. (11). West ST Sh. (12). SE P. (13). East T. (14). Chiili. (15). West T.

For determining the quantitative estimation of seismic danger, was conducted the comparison of three groups of data on each quasi-homogeneous zone.

Seysmotektonicheskiye data on powerful earthquakes include makroseysmicheskiye descriptions of the destructive consequences of powerful earthquakes, instrument/tool data or powerful earthquakes and constructed on them map/charts of the epicenters of powerful earthquakes and map/chart it izoseyst. In view of the small time interval for which are assembled data on powerful earthquakes, it is necessary to utilize observations of weak earthquakes.

Seysmostatisticheskiye data on weak earthquakes were utilized during the delineation of the zone of equal seysmichekoy danger and graphing of frequency to evaluate K_{max}.

Seysmotektonicheski are data. Because of tectonic data are refined the boundaries of quasi-homogeneous sections. During the determination of the maximum intensity in each zone, were accepted into consideration the maximum energy of earthquake after it ~~shchs-ycolet~~ 50-100 let., contemporary seismic activity and tectonic data (Table 24).

In the majority of cases, the estimatior of danger according to seismological data O_c coincides with the estimation of danger according to tectonic data O_T :

$$O_c + O_T = O_{cT}. \qquad (3)$$

However there is the zcne where $O_c > O_т$. If seismological estimaticn is statistically is reliably based, then it is equated tc consistent tektono-seismclcgical estimaticn O_{cT} , i.e., is accepted $O_{cT} = O_c$. So, the zone, prokhcdyashaya frcm Namangana to Andizhanu (Fig. 180, II-ф), is considered 9-scale-number, although acccrding tc tectcnic data it is related to the seccnd category.

If the reliability cf seismclcgical estimaticn is low, then as simultaneous estimation is accepted the ball, intermediate between seismclcgical and taktonicheskoy estimations, i.e., $O_c > O_{cт} > O_т$. Sc, in lower current r[P]cf Syrdar'ya in the regicn of Chiili in spite cf the existence of one epicenter with K = 15-16, the maximum intensity on map/chart is lcwered/reduced frcm 9 to 7 balls in ccnnection with the weak seismic activity cf this region and its reference tc III to category acccrding tc tectcnic data (case 7a, Table 24).

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There are also zones, for which $O_c < O_т$. These zones cbtained the simultaneous estimaticn, exceeding seismclcgical and equal cr less tectonic, i.e., $O_c < O_{cT} \leq O_т$. If cn tectcnic criteria zone can be related to I cr to II categories, but in it are rct noted earthquake with K > 15 (9 balls and more), ther the determiration of the maximum

intersity causes difficulty. In these cases taking into account tectonic data, the intersity of zone rises in comparison with the intensity of the most powerful earthquake which sometimes noted in this zone. as an example can serve the region of central Tien Shan, which is related to 8-scale-number zone, although to us is known only one earthquake by the force of 7 balls.

It is important to emphasize the inevitability of the existence of such zones for which the estimation of danger according to seismological and tectonic data must not coincide. This noncoincidence can have different reasons. Basic is nonconformity between the stressed state and the strains of the earth's crust during the last/latter decades (on which depends the contemporary characteristic of seismicity) and the characteristics of strains and stresses of crust, average for millenium and millinov of summers (by recorded methods of tectonics). Can have a value also the different degree of the study of seismicity and tectonics.

The account of the propagation of jolts according to seismological data. because of the known laws governing damping seismic oscillation/vibrations with removal/distance from epicenter (Medvedev, 1968), it is possible to fulfill the following constructions on the boundary of two zones with different seismic danger. Let us assume that in zone with large danger occurs the most powerful earthquake from epitsentrm of very land edge. Then jolts, equal intensities in epicenter, are spread to the determined distance

into the less dangerous zone where such powerful their own earthquakes do not appear. Still further from epicenter are arrange/located consecutively the bands of the propagation of less intensity. One of them in intensity is equal to their own earthquakes of less dangerous zone. The nearest to epicenter boundary of this band is accepted as the final band edge of different danger on the map/chart of seismic division into districts (Fig. 184).

Account of the propagation of jolts according to tectonic data. To the tectonic factors, which affect the propagation of seismic oscillation/vibrations, they are related:

1. Power/thickness of the covering of the unconsolidated sedimentary rocks, which possess powerful wave absorption, and the composition of basement rocks with different absorption. The concrete/specific/actual values of the limits of power/thickness and the corresponding to them characteristics of weakening jolts with distance thus far yet determined.

2. Strike/course and the degree of the strains of layers, folds and discontinuities. At opedelennom distance from the epicenter transversely of strike/course, the jolt on the average is to 1 ball less, than at the same distance along strike/course.

3. Large deep zones of discontinuities. During the propagation of seysmichesky wave, they especially strongly are absorbed during the

intersection of the deep zones of discontinuities. Is possible also their reflection from the healed by veir/strands discontinuities.

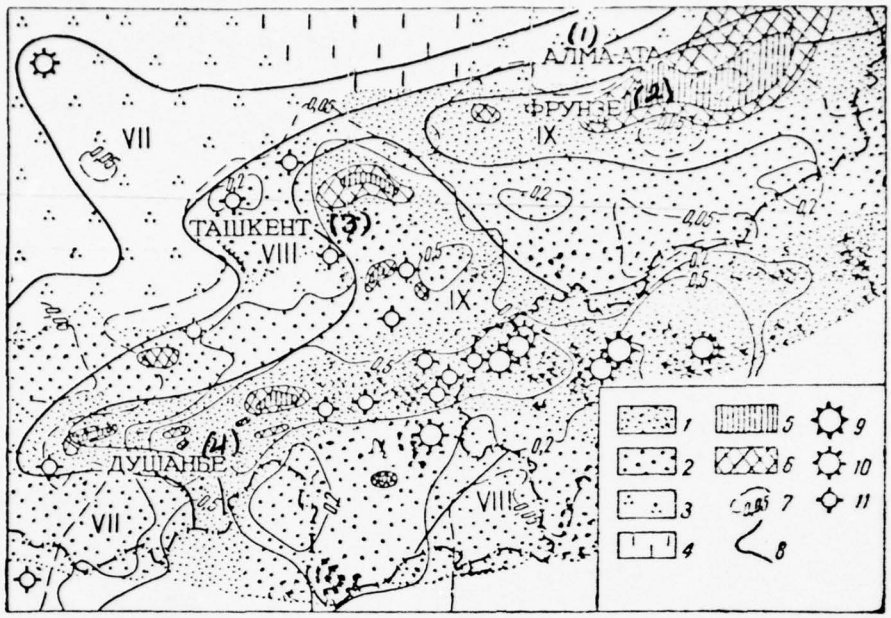

Fig. 184. Diagram of seismic division into districts and basic seismological data, used for its composition. Zones with different seismic danger according to geological data: 1 - I category; 2 - II category; 3 - III category; 4 - IV category. Areas with the different intensivnot'yu of the jolts: 5 - 9 balls; 6 - 8 balls; 7 - the isoline of the seismic activity A_{10}; 8 - the band edge of seismic division into districts. Classification on the energy classes: 9 - K = 18; 10 - K = 16; 11 - K = 15.

Key: (1). Alma Ata. (2). Frunze. (3). Tashkent. (4). Dushanbe.

Data relative to that, on how many balls of oscillation/vibration can be attenuate/weakened by such zones until are generalized.

The detailed account of the enumerated tectonic factors still not entered into practice.

General characteristic of the map/chart of seysmorayonirovaniya (Fig. 184). nine-scale-number zone included all regions where in the past already appeared earthquakes with K = 16-18 and activity A_{10} > 0.5. In this zone enter almost by pillar the bands of I category of danger according to tectonic data. Band edges are almost everywhere moved aside from it izoseyst 9 balls of past earthquakes.

Force-eight zone has epicenters of earthquakes with K = 15 and activity $0.05 < A_{10} < 0.5$. It in essence coincides with bands II category in tectonic data. The Izoseysty of 8 balls, with the exception of the little-known region of Chiili, nowhere pass after the apparitors of this zone.

In "-scale-number zone are noted the epicenters with $K \leq 14$. The seismic activity A_{10} usually less than 0.05, but by places rises to 0.5. The large part of the zone is arranged in bands III category, but sometimes coincide with bands II category in tectonic data. With the exception of the region of Chiili, the zone has an izoseysty of past earthquakes not above 7 balls intersity.

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CONCLUSIONS.

1. Tashkent is arranged in the zone of the boundary of the region of the newest makings more active of tectonic motions, by secant with respect to tectonic zonality. This seismic dangerous zone is drawn from Tashkent to Samarkand.

2. Many most dangerous zones can not have on surface the large numbers of outcrops of tectonic discontinuities (northern podnozh'ye of Kirghiz spine/ridge. Pritashkentskaya plain).

Existence at the depth of tectonic discontinuities can be revealed with the aid of different geophysical methods.

3. Is necessary the further development of the procedure for seismic division into districts. Taking into account the special urgency of this question for the regions of Tashkent, Alma Ata, Frunze, buildings of high embankments, expediently during the basis new are given on seismicity, tectonics, structure crusts taking into account systematic developments to compose the map/charts of the seismic division into districts of Central Asia. One should select the topograficheskuyu principle of larger scale, for example, 1:1000000, which will make it possible the more full to consider data of the epicentral expeditionary studies which to insufficient degree are used during the composition of the last/latter version of the

map/chart of seysmorayonirovaniya.

4. The existing map/chart of seismic division into districts must be refined by the more full/total/complete agreement of the estimations, based on seismological and tectonic data. Specifically, require review the regions of Chiili, Leninabad, Kurgan-tube, Samarkand.

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Chapter II

SEISMICITY OF THE TERRITORY OF UZBEKISTAN/~~THE~~ HISTORY OF INVESTIGATIONS.

Earthquakes in uzbekistan are known long. However, the accumulation of the systematic information about them is initiated only in the second half of the XIX century. The information about the arrangement/permutation of the seismic centers of earlier periods is connected with the history of the population of Turkestan edge. Therefore to us send the remainder separate data on the effect of the powerful jolts, which revealed in the most settled places. The first of the known here earthquakes is mentioned in the "catalog" of I. V. Mushketova and A. A. Orlov (1893) as "semidesyatidnevnoye earthquake in Trans-hydroxyane" - to present Bukhara - in 818 r.

In 838, according to the "enumeration of earthquakes" A. A.

Semenova (1958), "in Fergane happened powerful earthquake, and many houses were destroyed".

During the years 1208-1209 occurred powerful earthquake in Khorezme (Barthold, 1900); in 1490 - in Samarkand (Semenov, 1958). In 1602 in the northern part of the Ferganskoy valley, powerful earthquake completely destroyed the stiergth of Akhsy, arrange/located in epicentral zone (Gorshkov, 1949). The Mukhamed of Takhir-ben-Abdul' Kasym so describes this earthquake: "... water of Syrdar'i left the shores and flood/ignited that adjacent to river mestnost'... Enormous derev"ya were reversed from the Earth and fell. Houses were destroyed to basis/base, and much people perished hearth by their ruins".

Was preserved the interrupted/fragmentary information about the destructive earthquakes of end of XVIII and of the first half of the XIX certury. In 1797-1798 "in Maveranakhre occurred great earthquake, which is not bygone from immemorial times. So, in strength Urgut, in the region of Samarkand, all corstructior of tale are inverted so that even the piece of wall clay (by weight) in polsira there could not be found" (Semenov, 1958). "In 1821 or in the following bygone the earthquake in Bukhara was extended to Samarkand, where it destroyed towers ulug-to Beck's medrese" (muskets, Orlov, 1893).

In 1822-1823 occurred extremely powerful earthquake into the Fergane, which was being especially perceived in Kokandskom district.

It bygone so terribly and tested by the population of calamity so are great, that according to of eyewitness, "in all centuries and times nothing similar anyone tested nor saw. Many houses is bygone destroyed. Population constructed to itself huts from reed and in them habitable; in mountains many families atscrted the earth/ground.

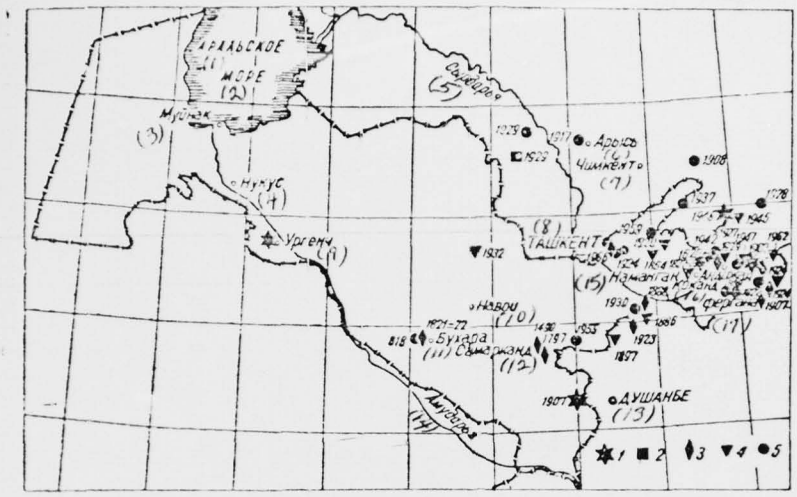

Fig. 185. Map/chart of the powerful earthquakes of uzbekistan. 1 - I = 9 balls; 2 - I = 8-9; 3 - I = 8; 4 - I = 7-8; 5 - I = 7 balls.

Key: (1). Ardl'skoye. (2). Sea. (3). Muynak. (4). Nukus. (5). Syrdar'ya. (6). Arys'. (7). Chimkent. (8). Tashkent. (9). Urgench. (10). Navoi. (11). Bukhara. (12). Samarkand. (13). Dushanbe. (14). Amudar'.

Soil opened wide and from there with noise it emerged black vapor; water of groove/passes and creeks boiled as in kciler, and they spread on the earth/ground. The Tolchiki and the jolts of soil continued many days during the post of months" (Semenov, 1958).

In the second half the XIX century appear the descriptions of separate/individual powerful earthquakes and their catalogs (Cherevanskiy, 1868; Borzna, 1868; Severtsev, 1868; muskets, 1891; muskets Orlov, 1893; Leonov, 1898, 1899). In the beginning the XX century are published systematic catalogs (Chernyshev, etc. 1910; Barthold, 1900; Bottger, 1924).

The more regulated information about earthquakes in uzbekistan we find ir V. N. Spesivtsevoy's works (1939); by V. N. Spesivtseva, G. P. Pot and V. V. Popova (1941); N. A. Khalfin (1949); by Ye. M. Butovskoy (1948); G. P. Pot (1949). In the most complete and systematized form of the information about the powerful earthquakes of eastern uzbekistan, are contained in the works of Ye. M. Butovskoy, A. T. Bidge et al. (1961) and by Ye. M. Butovskoy, by A. I. Zakharova, V. K. Iodko et al. (1964). The given works are placed as the basis of the construction of the map/chart of the powerful earthquakes of uzbekistan (Fig. 185). On it for the earthquakes of the past, is given only the lower limit of intensity. Of all existing at present knowledges, strongest in territory of the Uzbekistana of tale the 9-scale-number earthquakes of 1209 in Khorezme, on 1821 in Fergane, 1902 ir Andizhane and 1907 in Karatage.

A greatest quantity of earthquakes - 7-8 balls occurred in Ferganskoy valley. As it notes Ye. M. Butovskaya (1961), epicenters of these earthquakes are arranged mainly in narrow band along current r. Karadar'ya on the line of Kurshab-Andizhan-Namangan. Their origin/hearths more or less regularly migrate in time, moving from the east to west and back, which is explained by the author by the life of tectonic joints in this region.

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Are since olden times known the facts of the manifestation of powerful earthquakes to 7-8 balls in Tashkent: during February 1868 (7 balls), during April 1868 (7-8 balls), during June 1924 (7 balls), during April 1966 88 balls). Their epicenters were located both in adjacent more seysmichnykh ranges and in the city itself.

Figure 185, shows also the powerful earthquakes of the nearest epicentral zones, which are arrange/located of the boundaries of republic. This 9-scale-number Chatkal'skoye earthquake (1946), which revealed in Tashkent with the force of 7-8 balls, and the earthquake of 1929 in Chiili with probable force in the epicenter of 8-9 balls, but in Tashkent - 4 balls.

Instrument/tool observations of the earthquakes of the investigated territory are initiated from 1911, when on Central Asia's first seysmichekoy station "Tashkent" of tale are

established/installed the seismographs of B. B. Golitsyn's system.

The results of processing and analysis of instrument/tool observations in uzbekistan are given in Ye. A. Rezvoy's works (1936, 1939, 1947, 1950), N. A. Vvedenskoy (1954, 1961a, 1961b, 1962) and M. B. Bernikova (1939).

In 1957-1958 under Ye. M. Butovskoy's, management/manual are systematized data on the seismicity of uzbekistan (" the atlas of earthquakes in the USSR", 1962; "earthquakes in the USSR", 1961). For a series of regions, are developed the new hodographs, which made it possible to raise by an order accuracy of the determination of the position of seismic centers (Butovskaya, etc. 1962-1963; Zakharov, 1962a; Atabaev, 1962).

Is studied the seismicity of Fergansky valley (Butovskaya, etc. 1961a), Pritashkentskogo and south regions, center section of the Chatkal'skogo spine/ridge (Is Butovskaya, etc., 1964), eastern Fergany (Butovskaya, etc. 1966).

Extensive work on systematization and aralysis of the enormous material of seismic observations in uzbekistan from 1911 on 1961 is carried out into 1960-1962 during the preparation of the map/chart of the seismic division into districts of uzbekistan (Atabaev, etc. 1968). As a result of these investigations, are acquired ischernyvayushchiye data about all earthquakes of eastern uzbekistan

with M $\geq$ 5.5, i.e., with K $\geq$ 14, beginning with the latter is cre fourth past century. Subsequently the lower threshold of the earthquakes, included by observations, was reduced. So, from 1911 it is possible to consider full/total/complete the information about the earthquakes of eastern uzbekistan with M $\geq$ 5 1/4, K $\geq$ 13.5; since 1929 - with M $\geq$ 5, K $\geq$ 13, since 1951 - with M $\geq$ 3.5, which corresponds to K $\geq$ 10; with 1960 g - M $\geq$ 3, K $\geq$ 9. Transition from one M to next is realized according to formula T. G. Rautian (1960): K = 1.8 M + 4.

SEISMIC DIVISION INTO DISTRICTS OF THE TERRITORY OF UZBEKISTAN.

The map/chart of the seismic division into districts of uzbekistan, confirmed by government organ/controls and officially acted in the period of the Tashkent earthquake on 26 April 1966, is comprised in 1962 (Fig. 186).

Principles of the seysmorayonirovaniya of the USSR in 1962. The degree of the seismic danger of one territory or the other is defined by maximum ball I_{max} the intensity either the "forces" of supposedly possible seismic jolt in this range, regardless of the fact, as frequently such jolts can here occur - one time into 50 summers, or one time into 50,000 summers (Medvedev, 1961, 1968). The ball is determined predominantly on the basis of the description of the destructive effect of earthquake, according to the known "scale of the intensity" of Gost 6249-52 (Medvedev, 1952).

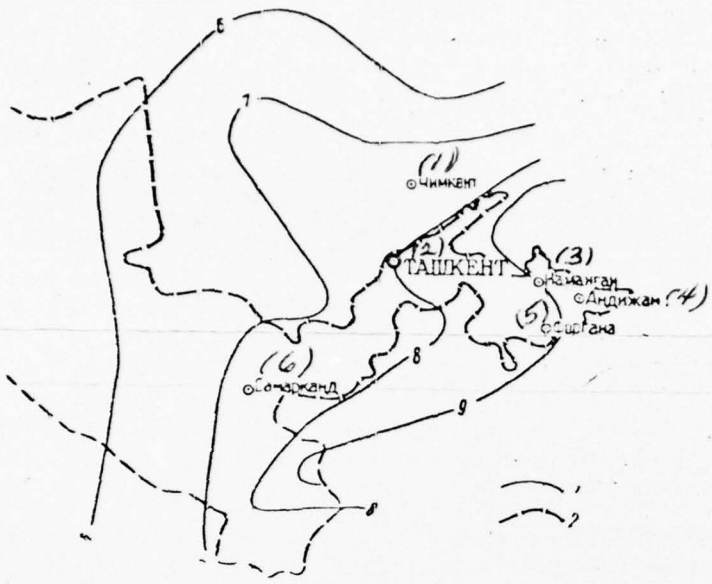

Fig. 186. Diagram of the seismic division into districts of Uzbekistan. 1 - the boundary of the seismic zcy of different intensity; 2 - the border of the Uzb.SSR.

Key: (1). Chimkent. (2). Tashkent. (3). Namangan. (4). To Andizhan. (5). Fvrgana. (6). Samarkand.

The methods of mapping of seismic division into districts are described in the work of Medvedeva (1961). These map/charts are obtained "as a result of combined analysis of seismological, engineering-seismological and geological materials". Work on division into districts is divide/marked off into two stage.

On the first "is reveal/detected the forecast/prediction of seismicity, i.e., the prognozzemletryaseriy, referred to the zone of origin/hearths, but not to the surface of the Earth". Of course, this determination does not have direct/straight relation to the real forecast/prediction of earthquakes, i.e., to the forecast of their value, place and time of the emergence: with seysmorayonirovanii the time is not establish/installed.

On the second "is reveal/detected the possible difference in the intersity of jolts on the surface of the Earth" on the basis of indicated data on the "forecast/prediction of seismicity" taking into account the information about the depths of origin/hearths. "In this case are utilized data on the relationship between its magnitudcy earthquakes (value by its in origin/hearth) and intensity in epicenter, expressed in balls". In practice they try to consider at each point the maximum jolts, of course, not only from "its own" origin/hearths, but also from the origin/hearths of large earthquakes with epicenters in adjacent ranges.

The intensity of the expected earthquakes the limits of the "contoured zones" is determined "on the basis of engineering-

seismological data on the destructive consequences occurred here earlier than the earthquakes of the greatest intensity". By this in essence it is allow/assumed, that within the limits of each supposedly the uniform in seismogeological relation "contoured zone", isolated predominantly according to the qualitative considerations of geological character (including the common/general/total acquaintance and with seismicity), at any point of zone possibly the earthquake, equal in magnitude in origin/hearth, or by the intensity of oscillations on the surface of the Earth, to really/actually observed at least in one of the points of the same zone ..." in this case is considered the information about the frequency of the earthquakes of different intensity in the range in question".

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As precisely this must be conducted, in instruction on seysmorayonirovaniyu 1962, it is not formulated. Yes at that time and difficult bygone this to make, since it seemed that the frequency of earthquakes express as is known, by the seismic activity A and by the connected with it values, direct/straight relation to the mapped cut value maximum intensity I_{max} does not have. Activity A, of course, has direct/straight relation to the repetition frequency of jolts - to sotryasaemosti B. But indeed this frequency with division into districts 1962 officially was not considered.

Later, with the chalchulations of maximum possible earthquakes

K_{max} and of sotryasaemosti B communication/connection between A and I_{max} is bygone is established/installed through a series of other, intermediate couplings. With the regulation of the procedure for division into districts 1962 activities A was abstract/removed the only auxiliary, essentially only illustrative role. In the majority of the ranges of the Soviet Union so this is bygone. In uzbekistan the seismologists went by their way and placed the seismic activity A as the basis of all considerations and calculations according to division into districts.

Seismic division into districts of uzbekistan in 1962. Based on materials of observations of weak earthquakes in republic, is constructed the series of the map/charts of the seismic activity A by different methods; some of them are proposed and elaborated in the A.S. of the Uzb.SSR (Butovskaya, Zakharov, etc. 1964).

On the map/charts of activity, are taken the points at which actually occurred large earthquakes and at which were known the value of maximum intensity I_{max}. As a result of the comparison of these values with the value of activity A at the same points, is constructed the graph/diagram of correlation dependence I_{max} on A. By knowing A at any point, it is possible to find for it assumed to be value I_{max}, even if powerful earthquake there still not was observed. Obtained relationship I_{max} (A), given, and served as principle for the isolation of the ranges of different possible maximum intensity I_{max} on the basis of seismological data.

(1) Сейсмическая активность A (A_{10} в год на 1000 км²)	(2) Градиенты скоростей вертик. движений, год$^{-1}$	(3) Баллы I_{max}
1	$100 \cdot 10^{-10}$	9
0,5—1,0	$10 \cdot 10^{-10}$—$30 \cdot 10^{-10}$	8
0,2—0,5	$1 \cdot 10^{-10}$—$3 \cdot 10^{-10}$	7
0,2		6

Key: (1). Seismic activity A (A_{10} per annum cr 1000 km²). (2). Gradierts cf speeds vertik. mctions, god^{-1}. (3). Balls.

Thus, required by instructions the twc-stage nature of investigatien with the establishment at first cf the band edges cf the maximum possible earthquakes cf different value in origin/hearth in uzbekistan is replaced by the establishment immediately of communicatien/connection cf activity A with skin effect I_{max}.

Obtained in this way ct the range different I_{max} then are tcuched up with the aid cf map/charts it izcseyst it izoseyst the cbserved earthquakes. Indicated the map/charts cf divisicn into districts value I_{max} cannct be less than actually cbserved. Specifically, this ccrrectien it was necessary tc make for a territory r cf Tashkert.

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Here was cbserved the lcw activity A < C.5, which would make it pcssible to relate it to the rarge cf 7 balls (Table 22). But during Chatkal'skcm earthquake (2 XI, 1946), with crigin/hearth at a distance, are more than 200 km cf Tashkert, in city are noted 7-8

scale-number jolts. This served as the reason for the reference of Tashkent to 8-scale-number zone with division into districts in 1962. For this very reason the Tashkent earthquake on 26 April, 1966, is not bygone for seismologists not expected in the relation to intensity.

With the aid of another procedure for the interpretation of seismological data, developed later (Bizrichenko, 1964b, 1966a) and it is based on the correlation of the seismic activity A with value K_{max} earthquakes in origin/hearth, is established/installed the possibility of emergence in the region of Tashkent the local earthquakes of this intensity, whereupon this calculation is made for 2-3 months to earthquake 1966 (Zakharov, Seyduzova, 1969).

Besides seysomologicheskikh with the division into districts of the territory of uzbekistan 1962, are used geological data. To them they are related brought about the gradients of the average speeds of the vertical displacement of the buried compensating surfaces for tens of millions of summers (from Cretaceous and Paleogene time to our days) and about length and width of the zones of deep fractures (Atabaev, etc. 1968; Table 22).

The comparison of the zones of different intensity, isolated according to data of seismology, on one hand, and geology - with another, showed their good agreement. This comparison was carried out only by qualitative, visual way, without the estimation of the weights (degree of reliability) of the compared values and without the

quantitative estimation of the degree of their conformity. This procedure is generally characteristic for seysmorayonirovaniya 1962.

The final, officially confirmed map/chart of seysmorayonirovaniya on the larger part of the territory will agree with zones I_{max}, isolated according to seismological considerations. In 6 scale-number range, this agreement is full/total/complete. In the zones of higher balls, are differences. So, the region of Samarkand seismologists related to 8 scale-number zone, and the geologists - to 7 scale-number. The region of Tashkent the seismologists and the geologists related to 8 scale-number range.

Map/chart of the seysmorayonirovaniya of uzbekistan 1962. On this map/chart) Fig. 186) are shown the zones of different maximum intersity (I_{max}) - from 6 to 9 balls.

Devyatiball'naya zone occupies the center section of the range of Chatkal'skikh spine/ridges, stretching into the eastern part of the Ferganskoy valley. Its western boundary passes near the cities of Namangan and Fergana. Further it goes in south and south-west directions into Tadzhikistan and seizes yenisey'skuyu territory on the north of Surkhandar'inskoy range in the region of Sharguni. The zone is characterized by the increased values of seismic activity - $A_{10} \geq 1$ and the gradient of the speed of tectonic motions - to $100 \cdot 10^{-10}$ god^{-1}. Here are arrange/located the epicentral zones 9 ball'nychkh of the earthquakes: Chatkal'skogo, 1946, with M > 7, Andizhanskogo,

1902, with M = 7 1/4 and Karatagskogo, 1907, with M > 7 1/2.

Vcz"miball'naya zone on north occupies the regions of spine/ridges to Karzhantau. Ugamskcgc and Eskemskogo. To the south it stretches itself by the hand between cities Tashkent, Namangan and Fergana and further departs intc Tadzhikistar, from it - into the Surkhardar'inskuyu range of the Uzb.SSR, where it adjoins from west 9 scale-number zone in the region of the rcrthern part of the spine/ridge Baysuntau. In this zone the value of seismic activity is changed from 0.5 to 1.0; the gradient of the speed of tectonic motions is from $10 \cdot 10$ to $30 \cdot 10^{-10}$ god^{-1}.

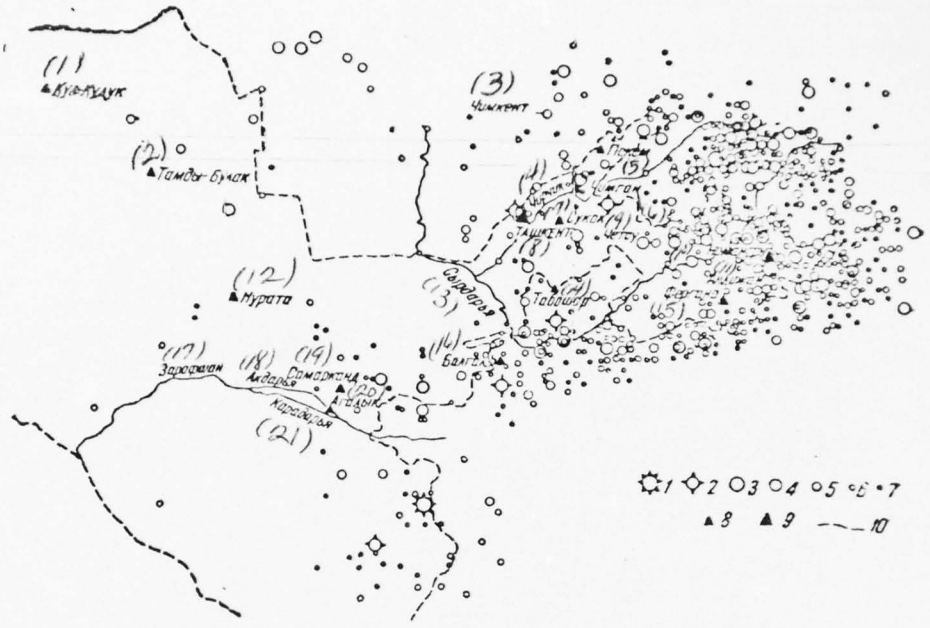

Fig. 187. Map/chart of the epicenters of the earthquakes of Uzbekistan and it mountain framing-classification on the magnitudam: 1 - M :ml 7, 2 - 6 :mg M :mg 6 1/2; on the energy classes: 3 - K = 14; 4 - K = 13; 5 - K = 12; 6 - K = 11; 7 - K = 10. Seismic stations: 8. ekspitsionnye; 9 - staticnary; 10 - the border of the Uzb.SSR. Key: (1). illegible. (2). Tamdy-Bulak. (3). Chimkent. (4). Chirchik. (5). Pskem. (6). Chitgan. (7). Sukok. (8). Tashkent. (9). To Chetsu. (10). illegible. (11). illegible. (12). Nurata. (13). Syrdar'ya. (14). Tabcshar. (15). Fergana. (16). illegible. (17). Zarafian. (18). Akdar'ya. (19). Samarkand. (20). Agalyk. (21). Karadar'ya.

AD-A039 349 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 8/11
THE TASHKENT EARTHQUAKE (SELECTED CHAPTERS). PART I.(U)
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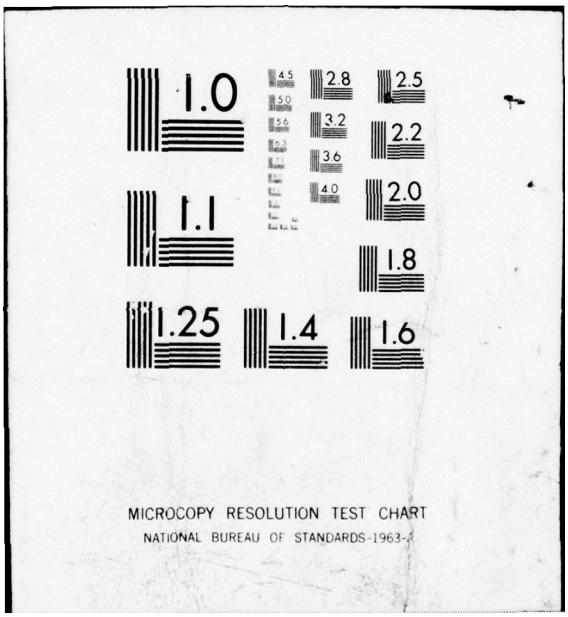
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MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-

Semiball'naya zone passes from region g. Chimkent (Kazakhstan) to south, occupying territory Syrdar'inskoy, western part Kashkadar'inskoy the basic area Surkhandar'inskoy ranges. Approximately from latitude g. of Dzhizak, western band edge almost along the meridian of 66° eastern longitude stretches itself to Afghanistan. This zone in eastern uzbekistan is characterized by seismic activity from 0.2 to 0.5 and by the gradient of the speed of tectonic motions to $3 \cdot 10^{-10}$ god^{-1}.

In Western uzbekistan both 7 scale-number and 8-scale-number the zones are established/installed insufficiently accurately. The grid/network of seismic stations began to be developed here only in recent years; therefore instrument/tool data on earthquakes to time of conducting seismic division into districts here actually are not bygone. At the same time the preserved information about the powerful earthquakes of the past (see Fig. 185) testifies to the noticeable seismicity of Western uzbekistan. This is confirmed also by the map/chart of the epicenters of earthquakes (Fig. 187); on this map/chart the number of earthquakes in Western uzbekistan less than the number of earthquakes in eastern uzbekistan, but sufficiently significantly, since earthquakes are here recorded by the moved away stations (obviously, their large part therefore is passed).

Thus, the procedure for seysmorayonirovaniya 1962 and the results of its application/use, in particular, in uzbekistan, are not deprived of deficiency/lacks. In the future is necessary the development of the more advanced procedure.

Sc, the only utilized, until now, expcrent cf the seismic danger of territory - maximum intensity I_{max} seismic cscillations must be supplemented by data obozhidaemoy medium frequency B_1 the repetiticn cf the seismic jolts of different intensity I, ircluding maximum $I=I_{max}$.

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Value B_I is called seismic sctyasaemost'yu. The previous index cf seismic danger I_{max} enters in the definitien cf sotryasaemosti as cne of its parameters.

The concept of sotryasaemosti B_I in seismclogy has, essentially, the same statistical, prcbabilistic character as those ccnsideratiens by which the engineers since clden times are guided by pi the calculation of the critical ccnstructions, called to resist cther fcrms of the natural calamities: the hurricane winds or the catastrophical seasonal flccds. During such calculations the medium frequency, cr the average repetition pericd cf the possible catastrophical effect of the determined value plays the leading role. Sc, embankment can be designed fcr this high seasonal flood which is enccuntered, on the average, cnly time intc thcusands of summers. Hcwever, this widely known and completely justified by practice approach did nct penetrate the regulaticr cf earthquake-proof building ir cur ccuntry.

As concerns the very intensity I (and I_{max}), it must byt'sc by time is translated from utilized the new corditicnal "balls", determined predominantly from the descripticns of the damage of buildings, to the quantitative khkharakteristiki of the seismic cscillaticns, controlled by instrument methcd. Is such, for example, maximum acceleration in the determined frequency bands. By knowing such values for different frequencies, it is possible to determine the time functicns of seismic cscillaticns, the "standard seismograms" of the expected zemletrseniy at the different points of the range in questicn.

The procedure of seysmcraycnircvaniya must be released from that large role of the subjective judgments and perform solutions, which is characteristic to it, until now,. It is necessary to systematically carry cut the evaluation of accuracy and probability (degree of authenticity) both of initial data during calculations of seismic danger and their results. This concerns not only seismological data which and earlier accepted to bygone estimate quantitatively in this respect (at least, in the better/best works on seismology), but also geological, the estimatich of reliability of which, as a rule, was not conducted. Final conclusicns according to composite data must be made taking into account the weights of different data, which enter the complex, depending on the degree of their reliability, determined by objective statistical methcds.

With this approach to seysmcraycnircvaniyu grow/rise the

requirements for volume and the quality of starting material, first of all seismological: to the completeness of coverage/scope and accuracy of coordinate determination of origin/hearths, including their depth, the accuracy of value determination of earthquakes are their seismic energies, the determinations of the laws governing a change in the intersity of seismic oscillations on the surface of the zemlivokrug of epicenter, to the determinations of the spectral composition of oscillations. Is necessary review, the rationalization and the unification of the methods of parameter determiration of focus seismicity and its response to the surface of the Earth.

Works on all these directions are initiated even after several summers to Tashkent earthquake 1966. Now they continue to be developed. At the present time is already obtained a series of significant results. They concern investigation both the focus seismicity - the seismic activity A and maximum possible earthquakes K_{max} and seismic response to the surface of the Earth - sotryasaemosti B_I for different intensities I.

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FREQUENCY OF EARTHQUAKES AND SEISMIC ACTIVITY.

Under the seismic mode/conditions of any range, according to Yu. V. Riznichenko (1958), is implied the totality of the seismic centers of this range, examine/considered in space and in time. For obtaining

the characteristics of seysmichskogc mode/ccnditions, is important the infcrmaticn about them lasting the srednikhzracheniya which include: the curve/graphs of the allccaticn cf frequencies cf the repetition of earthquakes according tc seismic energy (curve/graphs of frequency), the map/chart of the seismic activity A and cf maximum possible earthquakes K_{max}. As the initial data for this serve the map/charts cf the epicenters of earthquakes with indicaticns about their value K.

The map/chart of the epicenters cf the earthquakes of uzbekistan and its mcuntain framing (Fig. 187) is ccmprised during period cf 1868-1966 based on materials cf the wcrks, given in the beginning of this chapter. All seismic centers whcse epicenters are shown on this map/chart, are placed in the earth's crust. Cccrdinate determinaticns cf crigin/hearths, carried cut with the aid cf regicnal hodcgraphs according to data of the grid/network cf the highly sensitive seismic stations of uzbekistan fcr 1960-1966, they showed that their predominant depths compose 5-15 km. Earthquakes are here classified acccrding tc the value cf the energy class K ($10 \leq K \leq 14$); fcr the pcwerful earthquakes which cccurred in the period of ocinstrumental'nykh observaticns, were given magritudy M ($6 \leq M \leq 7$), and the ccordinate of epicenters were given cn makroseysmicheskim infcrmaticn. The distributicn cf the epicenters cf earthquakes acccrding tc the territcry cf uzbekistar ncrtnifcrm - their greatest denseness falls on the regicn of Fergansкoy valley and its surrcunding mcuntain ranges.

Cr map/chart (Fig. 187) are represented the epicenters of earthquakes from K $\geq$ 10, recorded in the territcry of uzbekistan during period of 1868-1966. But for this time repeatedly were changed reccrding ccnditions and it was reduced the lower limit K fcr the earthquakes, included by cbservaticns. In crder to obtain the undistcrted ccncept about the parameters of seismic mode/conditicns, their calculations necessary tc carry cut taking into account the earthquakes, representative cn energy. Therefcre are selected thcse earthquakes whcse recording did not depend cr the lccation cf seismic stations. This material has cnly in eastern uzbekistan where into the rumber cf representative earthquakes fcr an entire territory entered earthquakes with the energy class K = 10, 11, 12, beginning from 1950, K = 13 - frcm 1929 and K $\geq$ 14 - from 1868, fcr the regions eksperditsicnnykh observations to them, were added earthquake with the energy class K = 8 and 9, beginning with 1961. Furthermore, frcm examinaticn are excluded the repeated tclchiki cf pcwerful earthquakes.

Frequency of earthquakes. The mcst impcrtant law of seismic mcde/ccnditions is the law cf the frequercy cf earthquakes, which expresses number distributicn cf earthquakes acccrding to the seismic erergy:

$$N = A \cdot 10^{-\gamma (K - K_0)}, \qquad (4)$$

where N is the average density cf earthquakes tc the class of energy E

$K \pm 0.5$ or density at point; A is a seismic activity to class $K_0 \pm 0.5$, i.e., the three-dimensional/space density of the earthquakes of a defined class of energy; γ - the slope/inclination of the curve/graph of frequency.

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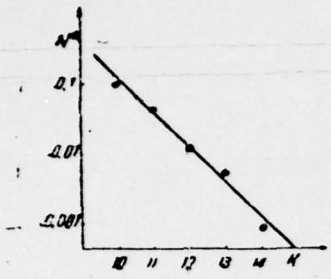

Fig. 188.

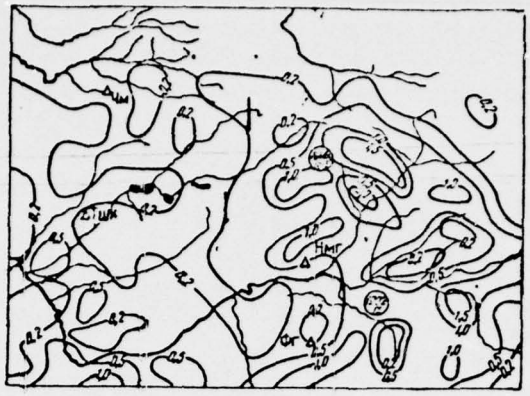

Fig. 189.

Fig. 188. the curve/graph of the frequency of the earthquakes of eastern uzbekistan (γ = 0.5; A_{10} = 0.11).

Fig. 189. Map/chart of the seismic activity of uzbekistan in isolines A_{10}.

In the system of coordinates K = lg E, lg N this distribution closely to linear. The slope/inclination of curve/graph γ = d lg N/dK, where K = lg E, it is one of the parameters of seismic mode/conditions (Fig. 188). The slope tangent of its γ, equal to 0.50 $\pm$ 0.05, shows that the number of earthquakes of each subsequent old class of energy approximately is triple less than preceding/previous one. This is the average law governing the frequency of earthquakes, found in other seismic regions, some deviations from which can be caused by the mestanymi or time/temporary special feature/peculiarities of seismicity.

The curve/graph of the frequency of the earthquakes of eastern uzbekistan is constructed for the interval of the energy classes K = 10-14, the periods of impressiveness of which are given above.

Seismic activity as the average lasting characteristic of the seismic mode/conditions of the entire investigated territory can be removed from the curve/graph of frequency (Fig. 188) in the form of ordinate lg A_{10}. Here A_{10} is a number of earthquakes of the energy class K = 10, which proceed on the average on single area (1000 km^2) per unit time (1 year).

The distribution of the seismic activity A_{10} according to the territory of eastern uzbekistan and its mountain framing is shown on map/chart A_{10} (Fig. 189). The zone of averaging here has a rectangular form and size/dimensions 0.2 x 0.2 geographical degrees. Values A_{10} at each point of map/chart (through 0.1°) were calculated

with the aid of the method of addition (Riznichenko, 1964) according to the formula:

$$A_{10} = N_{\Sigma} \frac{1-10^{-\gamma}}{10^{-\gamma(K-K_0)}} \cdot \frac{1000}{S \cdot T}, \qquad (5)$$

where N_{Σ} is the total number of earthquakes in the zone of averaging; $K_0 = 10$; K - the lower limit of energy class in region; S is an area of the zone of averaging, km²; T - the period of the impressiveness of the earthquakes of class K, elderly.

Entire territory of eastern Uzbekistan in terms of values A_{10} is divided into 2 parts - western and eastern.

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In the western part, which occupies the plains space of Pritashkentskogo region, predominate values $A_{10} = 0.2$ and below. In south-west to its angle is observed an increase in the activity to 0.5 on small areas. On the right shore of Syrdar'i, these ploshadi are timed to the southwest subsidences of Kuramirskogo spine/ridge and the region of Chinaza. To the south, on northern slopes of Turkestan spine/ridge (region to Uratyube), values A_{10} are equal to 0.5 and even 1.0.

The eastern part of the territory of Uzbekistan in question, which occupies Ferganskuyu valley and its mountain framing, is sharply

differentiated with respect to activity. The inherent background of seismic activity is raised relative to background in western part to 0.5. Maximum value (1.5) activity reaches in the region of Atoynakskoge spine/ridge. Here isolines A_{10} = 1.5 and 1.0 are elongated in southeasterly direction, contouring this spine/ridge. Almost transversely their strike/courses along Chatkal'skoge spine/ridge stretch themselves isoline A_{10} = 1.0.

The high activity A_{10} = 1.0 (and on the small section A_{10} = 1.5) is observed in extreme, the eastern, part of the Ferganskoy valley, timed to the coupling of the pedgroiy of Alayskoge and Ferganskoge spine/ridges. Here isoline A_{10} = 1.0 is elongated in meridional direction. And finally to the south g. of Fergany is arrange/located one additional zone of the increased activity with A_{10} = 1.0, timed to the northern slopes of Alayskoge spine/ridge. The general elongation of isolines with A_{10} = 0.5 or less also corresponds to the strike/course of the basic tectonic cell/elements.

MAXIMUM POSSIBLE EARTHQUAKES.

One of the main disadvantages in the seismic division into districts (Atabaev, etc conducted. 1968) is bygone the fact that it was restricted to the account of the information about already passed events. Between the fact, during the study of the seismicity of the active regions of the territory of the Soviet Union is noticed the tendency of the suitability of the epicenters of powerful earthquakes

toward the zones of the increased seismic activity. On this basis/base is constructed correlation dependence (Riznichenko, 1966a) between the value of the observed strongest earthquakes and the value of the activity, calculated in the neighborhood of their epicenters. This makes it possible to judge the value of maximum earthquake K_{max} at any point of the investigated territory by the level of seismicity, regardless of the fact, appeared here previously powerful earthquakes or not.

The distribution of value K_{max} according to territory can be presented in the form of the map/charts of the maximum possible earthquakes. For the first time such map/charts are constructed for eastern Sayan and a Dzhungarii (Riznichenko, 1966a) and eastern uzbekistan (Zakharov, Seyduzova, 1969) on the following dependence:

$$\lg \bar{A} = \alpha + \beta (K_{max} - K_0). \qquad (6).$$

Value $\bar{A}$ is calculated for certain area, "critical" for the preparation of the corresponding powerful earthquake. The size/dimensions of this area are selected s.ucetom, that the vlichina of energy E_{max}, which isolated in the origin/hearth of powerful earthquake, is proportional to the volume of the range of its preparation:

$$E_{max} = 10^{K_{max}} = cr^3, \qquad (7)$$

where r is a radius of this range; c - proportionality factor.

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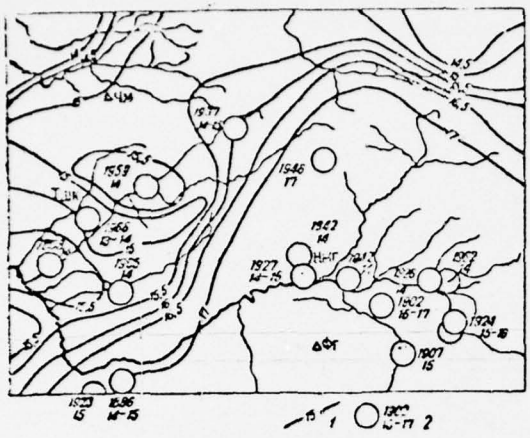

Fig. 190. Map/chart K_{max} eastern uzbekistan. 1 - isoline K_{max} ; 2 - the epicenters of powerful earthquakes (1902 - the year of vozrikrovsniya; 16-17 - the class of energy).

For the construction of map/chart K_{max} eastern uzbekistan is used the information about earthquakes for 1868-1964. The most powerful earthquakes in the investigated territory are Chatkal'skoye (1946, K = 17) and Andizharskoye 1902, K = 16-17). For them is calculated value $\overline{A}$, the zones of averaging of which are obtained from dependence (2). It turned out that the calculated values $\overline{A}$ will agree well with the correlation dependence of form (1) whose parameters $\alpha = 2.84$; $\beta = 0.21$; $K_{\alpha} = 15$ (Riznichenko, 1966a). This gave the basis to utilize the given parameters during calculations of values K_{max} the possible earthquakes in our territory.

On map/chart K_{max} for eastern uzbekistan (Fig. 190) the isoline of the maximum possible earthquake K = 17 contours Ferganskuyu depression and its mountain framing are Ferganskiy and Chatkal'skiy spine/ridges. In northern and western directions values K_{max} decrease to fourteenth-fifteenth energy class.

During the comparison of calculated values K_{max} with really/actually observed, is established/installed sufficiently good coordination. B the locations of origin/hearths with K = 13-17 all values of the maximum earthquakes which can there arise according to the calculation on the basis of seismic activity, than not less observed (Fig. 190). Map/chart K_{max} is obtained according to data on seismicity to 1964 inclusively. Tashkent on this map/chart is arranged in zone $K_{max} = 15$. Tashkent earthquake during April 1966 had value K = 13-14.

SEISMIC SOTRYaSAEMOST'.

The lasting average seismic danger in any place of the earth's surface is defined by the fact, as frequently, on the average, here can appear the seismic jolts of different intensity I. Any observation point experience/tests the jerk/impulses of any intensity I from each of the earthquakes, which appear in its environment. Is considered the effect of jolts both from close and from the moved away earthquakes, since the distant earthquakes of large force can cause at the investigated point of the jolt of the same intensity, as close weak.

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In general form the sum frequency of jolts - total sotryasaemost' B_{Σ_I} in the observed point with an intensity of I or above is expressed by the integral:

$$B_{\Sigma_I} = \iiint_V N_{\Sigma_I}\, dx\, dy\, dz, \qquad (8)$$

where N_{Σ_I} is the referred to the time unit and volume total number of those earthquakes with the gipotsentrami in volume element of V which give at this point of jolt with an intensity of I and above. Integration is spread to entire volume of the large where are encountered seismic centers (Riznichenko, 1966b).

Initial for the calculation of sotryasaemosti are data on focus

activity and on intensity I.

Data of the first kind are given in the form of the function of the frequency of earthquakes N (K), N they is given the number of earthquakes, referred to the time unit and volume (or area). K = lg E, E - the seismic energy of origin/hearth into dzhoulyas.

Usually this function is determined by the parameters: A is determined the seismic activity, $\gamma = -d \lg N/dK$ it is determined the slope/inclination of the curve/graph of frequency, K_{max} it is determined the maximum possible earthquake in this three-dimensional/space cell/element. Values A and K_{max} are mapped out. Value γ for the territory of eastern uzbekistan is shown in Fig. 188. The map/charts of the seismic activity A_{10} and of the possible maximum earthquakes are given in Fig. 189 and 190. Data of the second kind concern the dependence of intensity I or value K of earthquake, depth h and of the epicentral distance r_0. For calculation B_{Σ_I} was utilized expression $I \sim r^{n}$ where r - hypocentral distance. one of the parameters of this dependence is the attenuation index n.

During the substitution of the law of the frequency of the earthquakes in the form (4) into formula (8) is obtained the following expression for the total sotryasaemosti:

$$B_{\Sigma_I} = \frac{1}{10^{0.5\gamma} - 10^{-0.5\gamma}} \iint A \left(10^{-\gamma(K_1 - K_0)} - 10^{-\gamma(K_{max} - K_0)}\right) dS, \qquad (9)$$

where S is an area of the which surrounds the observed point range with epicenters on all surface elements $dS = r_0 dr_0 da$, which are located on different hypocentral distances $r = \sqrt{r_0^2 + h^2}$ and in different azimuths α from this point; r_0 is a epicentral distance; h - the depth of origin/hearths, accepted during calculations of constant, than is explained the replacement of triple integral in formula (8) dual; $K_0 = 10$ is the fixed value of the energy class of earthquake, which includes the determination of activity A; K_I - the exponent of the seismic energy, which isolated in origin/hearth, which causes at the calculated point jolt with value from the assigned intensity I_1 is above; K_{max} is the maximum possible earthquake on pad dS.

Sotryasaemost' was calculated for intensity I, expressed completely $\mathcal{E}$ energy flow.

In this case, is applied the law of facing the energy current density with hypocentral distarce, found empirically for the territory of Central Asia (Seyduzova, etc., 1962).

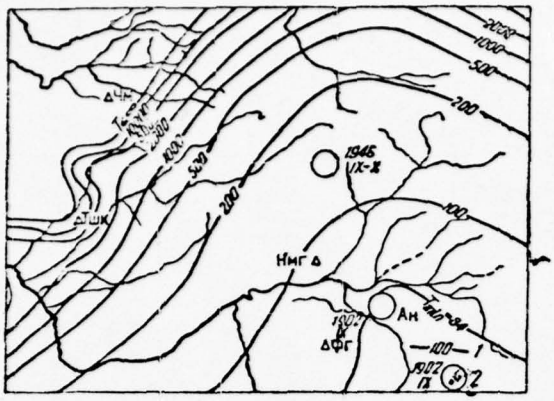

Fig. 191. Map/chart of the sctryasaemcsti cf eastern uzbekistar fcr $\mathcal{E}$ = 10^{12} ~~dzh~~ $\int$/km² (h = 1.66; γ = 0.5; h ~~=~~ $\leq$ 10 km). 1 - the isoline of the period cf the frequency cf jolts elderly; 2 - the epicenters cf the strcngest earthquakes (1902 - the year cf emergence; IX - intensity in epicenter).

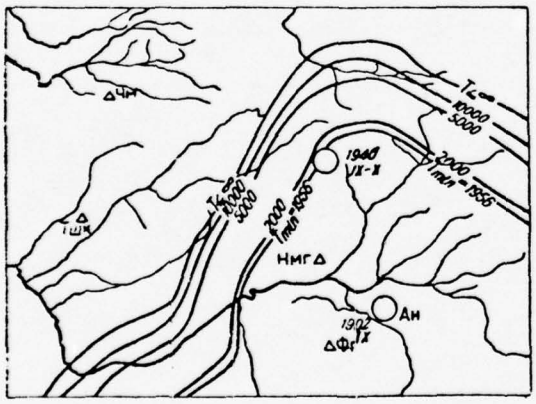

Fig. 192. The map/chart cf the sctryasaemcsti cf eastern uzbekistar fcr $\mathcal{E}$ = 10^{13} ~~dzh~~ $\int$/km² (ccnv. desig. see ir Fig. 191).

Then in formula (9) value K is calculated as follows:

$$\lg K_1 = \lg \varepsilon + 1{,}66\,[\lg r - \lg R] + \lg 4\pi R^2, \qquad (10)$$

where ε = I - the assigned magnitude of jolts at the investigated point; R = 10 km - a radius of the referents of sphere.

For machine calculation integration in formula (9) by the zamenenie summirovaniyem:

$$B_{\tau_i} = \sum_s \cdot A \frac{\left\{\left[4\pi R^2 \left(\frac{r}{R}\right)^{1{,}66}_{\varepsilon}\right]^{-\gamma} - (10^{K_{max}})^{-\gamma}\right\} 10^{\gamma K_0}}{10^{0{,}5\gamma} - 10^{-0{,}5\gamma}} \Delta S, \qquad (11)$$

whereupon dual integral in terms of alternating/variable r and α is replaced by one sum, since a change in the intensity of jolts was considered only depending on distance.

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According to formula (11) are obtained the map/charts of the seismic stroyasaemosti of the investigated territory (Riznichenko, etc. 1967, 1969) at the different values of the initial parameters. Map/charts were calculated for two intensity levels: $\varepsilon = 10^{12}$ ~~dzh~~ J/km² and $\varepsilon = 10^{13}$ ~~dzh~~ J/km², which approximately corresponds to jolts into 8-9 and 9-10 balls (Nersesov, etc. 1960, Figs. 191, 192).

On the first map/chart (Fig. 191) smallest period T_{min} the

frequency of jolts is equal to 84 years and is timed to the epicentral zone of 9-scale-number Andizhanskogo zemletryaseniya 1902. In northern and northwestern directions the period increases. In the region of the epicentral zone of Chatkal'skogo zemletryaseniya 1946 (its intensity is estimated at 9-10 balls) period it composes 130-140 summers, near the northern boundaries of the territory in question - 500-700 summers, also, in the region of Tashkent - 8000-10000 summers. Here subsequently during the comparison of the values of the periods of sotryasaemosti with the location of the epicentral zones of the strongest earthquakes it is necessary to keep in mind that during calculations of sotryasaemosti are considered data on earthquakes with $K \leq 13$.

On the second map/chart (Fig. 192) the smallest repetition period of jolts is equal to 1956. Iscline T_{min} covers much larger area - entire Ferganskuyu valley and its mountain framing. To the north this territory period reaches 10,000 summers, and of the northern boundaries of map/chart, its value is equal to infinity, i.e., virtually such jolts here must not be encountered. In analogous position is located the region g. of Tashkent.

During the calculations of the map/charts of sotryasaemosti conducted the level of the assigned intensity is limited by two values K for the following reasons. On the map/chart of the maximum possible earthquakes smallest value K_{max} for Uzbekistan it is $K_{max} = 14.5$. If seismic center with K = 14.5 is located on depth h = 10 km, then the

energy current density in epicenter will be about 10^{12} ~~dzh~~ J/km². Therefore $\mathcal{E} = 10^{12}$ ~~dzh~~ J/km² approximately it corresponds to 9-10-scale-number jolts in epicenter. Since in the territory of uzbekistan of earthquakes from 1 > 9-10 balls was not observed, value $\mathcal{E} = 10^{13}$ ~~dzh~~ J/km² was bygone was accepted as the upper limit.

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Chapter III.

SEISMIC ~~MODE~~/CONDITIONS OF near-Tashkent ~~PRITASHKENTSKOGO~~ REGION /~~SEISMOLOGICAL STUDY.~~

In Pritashkentskiy region enters the territory, included between 40-42.5° eastern longitude, i.e., in a radius 100-120 k, from Tashkert.

Instrument/tool recording the earthquakes of region as generally uzbekistan, is initiated from discovery/opering in 1901 with the first in average the azine of the seismic station of "Tashchkent". However, to 1911-1914 due to poor quality seismographic material, it was not possible to any accurately establish/install the place of origin of earthquakes, if they were not accompanied by destruction on surface.

After instrumentation during the years 1911-1914 stations

"Tashkent", "Samarkand" and "Alma Ata" by E. E. Golitsin equipment according to data of these stations and yeleseysnicheskoy grid/network of Russia (station "Pulkovo", "Irkutsk", "Baku", "Sverdlovsk", etc.) it became possible the more or less reliable determination of the epicenters of the powerful earthquakes of region. From 1868 are known data about all earthquakes in region with magnitudcy not less than 5 1/4 (Is Butovskaya, etc. 1964).

Beginning from 1927-1932, when seismic stations "Alma Ata" and "Samarkand", and also newly opened by "Frunze", "Andizhan" and "Chimkent" of tale are equipped with equipment of the system of E. M. Nikiforova, who well records close earthquakes, although with a small increase (from 300 to 700), the conditions of recording earthquakes somewhat were improved. Afterward 1932, in region were recorded all earthquakes with magnitudcy $M \geq 4$, but the determination of their epicenters it is not possible to consider reliable due to the one-sided location of stations with respect to origin/hearths.

With discovery/opening into 1939-1947 seismic stations of "Kulyab", "Dushanbe", "ok-garm" of the coordinate of epicenters in region began to be determined more reliable, since appeared data of south with respect to region stations.

Only from 1950-1952, when came into action the stations of "Fergana", "Namangan", "Dzhergital'", "Garm" and entire existing grid/network of stationary stations was bygone was re-equipped by

seysmometricheskoy equipment of D. P. Kirnos's system, the condition of recording earthquakes in region they were improved. The broadband frequency characteristic of this equipment makes it possible to record/write both distant and close earthquakes in the range of periods 0.1-10.0 s. Beginning with 1951 in region are known the epicenters of all earthquakes with magnitudcy M ~~=1~~ $\geq$ 3.5.

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Appearance into 1954-1955 highly sensitive expeditionary stations in the city districs of Dushanbe and Garm, equipped with equipment for the type of VEGIK, which possesses constant increase on the order of 10,000-20,000 for periods 0.05-0.8 s., significant improvements in the conditions recording in Pritashkentskom region did not give. These conditions remained constart/invariable to 1960, i.e., to the torque/moment of discovery/opening in the region of the Chatkalo-Kuraminskikh spine/ridges of the highly sensitive stations of uzbek seismological expedition (USE).

By the first on the seismicity of the Pritashkentskogo region of the tale of M. P. Bepnikova's work (1939) and N. P. Vasilkovskiy, M. P. Bepnikova (1940). In them are illuminated tectonic structure and the earthquakes of the small part of the region - (approximately 1/10 its area).

Data on the earthquakes of Pritashkentskogo region for 1929-1948

have in Ye. A. Rozovoy's raztakh (1947, 1950).

To the analysis of the seismicity of Tashkent is dedicated Ye. M. Butovskoy's work (1961b). At it is estimated the seismic effect of the earthquakes whose epicenters are arrange/located in different directions from Tashkent. Is given the copy of the earthquakes which judging by difference S-P, they occurred in immediate proximity of Tashkent. Such earthquakes for 1912-1951 yr.-11, for 5 of them the position of epicenters is determined.

Some information about the earthquakes of Pritashkentskogo region for the years 1950-1956 is placed in N. A. Vvedenskoy's works (1954, 1958), the dedicated to generalization instrument/tool observations of the earthquakes of Central Asia during this period. According to N. A. Vvedenskoy in this period in region, it occurred only 2 earthquakes at M = 3.5-4.

The generalized information about the seismicity of Pritashkentskogo region according to data of stationary seismicheskikh stations during the time from 1911 on 1956 is contained in the atlas of earthquakes in the USSR (1962) and N. A. Vvedenskoy's work (1961b). The Pritashkentskiy region is characterized by the weak seysmichnost'yu: on the map/chart of the common/general/total seismicity of Central Asia, comprised according to data of instrument/tool observations for the years 1927-1956, the zpitsentry of earthquakes are calculated by units.

The expeditionary investigations of seismicity to 1960 were carried out in region only occasionally. During 4 months of end 1956 and of beginning 1957 in Pritashkentskom regicr worked the grid/netwcrk of 5 highly sensitive staticns of the Tadzhik compcsite seismological expedition of the institute of physics of earth by the AS USSR = TKSE. They tale are placed cr area 0.5 x 0.5 geographical degrees in the region of Charvakskcgo reservcir fcr research on the seismclcgical conditicns of its territory. For time of observations, it is recorded 46 weak earthquakes of 6-10 energy classes.

On the basis of the cbservations ccrducted and generalization of data of regicnal grid/network fcr the preceding/previous years, I. L. Nersescv and A. M. Bagdasarcva drew the ccrclusicn about the low seismicity of region and the location of the basic epicentral zcnes cn his south-west and north-vosgccryx bcundaries. Potentially dangerous fcr the region of reservcir the authors considered only the zemletryaseya of the valleys of rivers Pskem and Angren, after making the ccrclusicn that the vraycne of the reservcir nct bygone of earthquakes is more powerful than 3 balls, ard effect from the moved away earthquakes did not exceed 6 balls.

In 1960 in region, they came into actior 5 highly sensitive staticrs, equipped with instruments of the type of VEGIK with increase cn the crder of 10,000-15,000. In connection with this appeared the pcssibility of recording the more numercus weak earthquakes of 9.8

energy classes.

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From this point on, is initiated systematic research on the seismic mode/conditions of Pritashkentskogo region.

The first results of research on the seismicity of the region, based on the observations of highly sensitive stations, are conducted with the seismic division into districts of Uzbekistan during the years 1961-1962. Under Ye. M. Butovskoy's, management/manual is carried out the systematization of all existing knowledges about earthquakes of region and their manifestation (Butovskaya, etc. 1964; Atabaev, Is Butovskaya, etc., 1968).

By this time tales are calculated the hodographs of seismic waves (Is Butovskaya, etc., 1962; Zakharov, 1962a), that made it possible to raise the accuracy of the determinations of epicenters in region by an order in comparison with determinations from Ye. A. Rozovoy's hodograph (1936). For all earthquakes, known in region during period of 1868-1962, are obtained energy characteristics (Atabaev, etc., 1963) according to classification T. G. Rautian (1960).

EARTHQUAKES IN TASHKENT.

Tashkent and its neighborhoods several times underwent the powerful

and perceptible earthquakes. Most powerful of them occurred 100 years ago. The information about its destructive consequences can be found in some newspaper report/communications, and also in the manuscript work of the Tashkent historian of the Mukhammada of the Salikha of the "Tarikhi of the zhadidayi of Toshkent" (new history Tashkent). "From 10 on 11 April into midnight in Tashkent occurred powerful zemletryaseniye... In the city of 11 domes of cemeteries and the dome of mosque To Khozrati the Akhrara of tale are destroyed to basis/base. Many people, who dropped down, remained under ruins. Earthquake continued about half-hour. The especially latter are four minute jolt bygone so powerful that if it continued an additional four minute, then on the surface of the Earth from the object/subjects confronting nothing would remain. After the damping of earthquake during one month the people of oshushchali weak jerk/impulses".

The day and the month of this earthquake are known, but its year remains disputable/debatable. In the opinion of A. Urinbaeva (1966), the earthquake occurred into midnight from 26 or 27 April 1866, since the author of the manuscript of the Mukhammad Salikh speaks on the following pages about the events, clear earthquake, but proiskhodivshchikh during April of 1282 hegira, which in new calculation/enumeration corresponds 1866.

V. I. Spesivtseva (1933) cite data on the earthquake in Tashkent or 4 February 1868. These are the bygone "very powerful earthquake, which was continuing 2 minutes. Some houses of tale are overturned.

seven balls". On this earthquake it is also written in the work of N. E. Vasilkovskiy and M. P. Bernikova (1940). Judging according to the description, this earthquake differed little from earthquake 1966 and was accompanied by numerous repeated shocks.

In another source it is said that "on 23 March (on new the stilo on 4 April) in 22 hours of 15 minutes g. Tashkent underwent sufficient to the considerable earthquake, which was continuing about minute. Earthquake began with the vertical shocks, which passed over soon to undulations. Being gradually amplified, it achieved this force, that all construction began to crack, to incline itself. By this earthquake are injured almost all buildings of city ..." (" stock exchange gazettes", May 1868) etc.

In newspaper "Russian invalid" it is reported that "this already third ... earthquake". Consequently, it is possible to assume that in Tashkent during 1866-1868 occurred several earthquakes.

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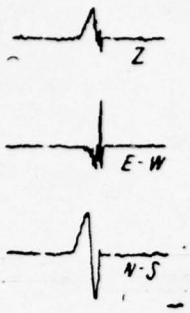

Fig. 193. Seismogram of the 1-scale-number earthquake on 10 July 1938, obtained on seysmostantsii "Tashkent".

The most powerful of them arose during April 1866, February and during April 1868. It is possible that the basic earthquake is bygone during April 1866, and the others were it powerful repeated push. In the contemporary scale of intersity, the intersity of this earthquake exceeded 8 balls.

Intense aftershocks by force to 7 balls were observed during Tashkent earthquake 1966 during 2 summers.

During the makroseysmicheskikh investigations of Tashkent earthquake 1966, are assembled some information, which confirm emergence in the past the century of several earthquakes with epicenter in Tashkent.

Judging by the stories of old residents, these earthquakes occurred in the region of Kazhgarki, in which ard is now arranged pleystoseystovaya range. Are how historically accurate these data to say difficult due to the absence of more reliable sources. Probably the epicenters of these earthquakes were located either in the region of Kazhgarki or near it.

As a result of the analysis of the first, relatively qualitative, seismographic material, obtained by Tashkent seismic station during period 1812-1930, g. into priests made the conclusion that "Tashkent itself is the epicenter of powerful earthquakes by force into 6 balls, but on certain sign/criterion and is above" (Vasilkovskiy, Repnikov, 1940).

The first powerful earthquake, which was possible to record by instrument/tool Tashkent seismic station, occurred on 7 June, 1924. The Gipotsentry of this earthquake and its iterative impulses are arranged under the center section of the city.

At central seismic station "Tashkent" has the notation one additional of powerful ('-scale-number) earthquake, which occurred on 10 July, 1938, in Tashkent focus zone (Fig. 193).

This is how describes G. V. Popov (1934) this earthquake: "epicenter into the SZZ of part of Tashkent. Center, judging by a small angle of departure of seismic ray/beam, extra-fine. Force of 6 balls. Was perceived the only second phase - the sharp, short jerk/impulse from bottom to top after which followed the perception of failure downward, in precise conformity with seismogram. Small object/subjects were shift/sheared from places. Some fundamental brick houses cracked. Some clay walls fell. Burst themselves timbers in ceilings. Water was splashed out from the filled vessels. Somewhere were observed small cracks in the earth/ground. There is one report/communication about a rapid decrease in the water to polmetra in the western part of the city".

The seismic station arrange/locates also several notations of weaker earthquakes (from those imperceptible to the e-I-scale-number) with epicenters within limits g. of Tashkent and its neighborhoods

during period 1914-1965.

N. P. Vasilkovskiy and M. P. Repnikov (1940) separate/liberate "Tashkent seismic origin/hearth" as independent seysmoaktivnuyu range, being based on the analysis of the seismographic material, obtained to 1939.

During March 1961 of the western region of Tashkent to central seismic station "Tashkent" entered the report/communications about insignificant underground jerk/impulses.

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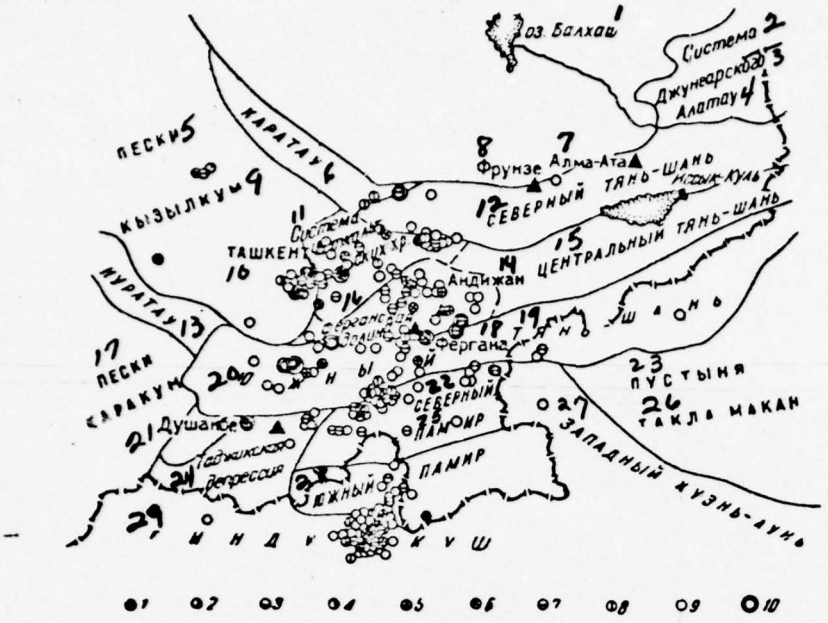

Fig. 194. Map/chart of the epicenters of the earthquakes, which were being perceived in Tashkent during period of 1866-1965. According to instrument/tool data siloyu: 1 - 7; 2 - 6-7; 3 - 6; 4 - 5-6; 5 - 5; 6 - 4-5; 7 - 4; 8 - 3-4; 9 - 3 ball and less. According to makroseysmicheskim data: 10 - 6-7 balls.

Key: (1). Lake balkhash. (2). system. (3). Dzhungarskogo. (4). To Alatau. (5). sands. (6). To Karatau. (7). Alma Ata. (8). to frunze. (9). Kizil-kum. (10). Tashkent. (11). System. (12). Northern tien shan. (13). To Kuratau. (14). Andizhan. (15). Tsentrla'nyy tien shan. (16). Fergarc. (17). Sands. (18). Fergana. (19). Tyan' of shan'. (20). Kaarakum. (21). To Dushakbe. (22). Northern. (23). Desert. (24). Tadzhikskiya. (25). Pamirs. (26). Takla is dipped. (27). Western kuzn'-lun'. (28). the south Pamirs. (29). Mndy large sum.

Sc, in the journal of the makroseysmiki of TsSS "Tashkent" are the notations: "the report/communication of the physician of Bekchetaevcy st. Bekzak, the blind alley of Maktab, 3. Between 11 and 12 hours of night from 19 on 20 March, 1961, of oshushchalsya underground jerk/impulse with hum".

The same occurred at night 20-21 March 12 hours of 30 minutes. and 21-22 March in 2 hours of 25 minutes (report/communication Sultanovykh, the same address), at night 24-25 March of 1961 12 hours 40 min. of oshushchalsya shock, but the less force than preceding/previous ones".

Everything noted by the inhabitants of this region jerk/impulses are sufficiently are distinctly visible on the seismograms of TsSS "Tashkent", moved away from the place of oshushcheniya on 6-7 km.

At the end of March of 1961 V. I. Ulomov with the colleagues in court of Sultanovykh equipped the time/temporary seismic station which veryvno worked during 2 months. Were possible to record two very weak, neoshushchavshikhsya and not otmechenny CSS "Tashkent", short jerk/impulse.

During the years 1963-1965 for seismic city planning of the territory of Tashkent central seismic station "Tashkent" organized seysmometricheskiye observations in 4-7 point/items of city. Since for the solution to stated problems it is not bygone of the need for obtaining the absolute time of arrival of seismic waves, entire

equipment worked in the waiting mode/conditions, i.e., it was included in the torque/moment of underground jerk/impulse. As a result of observations at northern station (Yunusabad) are reveal/detected the frequent jerk/impulses of local character whose nature is not established/installed, although part from them occurred in calm night time.

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Separate/individual tolchiki were recorded and by other urban stations, including the central seismic station "Tashkent", acting continuously. The majority of the jerk/impulses, recorded ASS "Tashkent", in intensity hardly it prevyshaet the level of urban interferences and therefore very difficult to judge their origin.

Besides its own earthquakes in Tashkent and adjacent to it regions, oshushchayutsya transit earthquakes, ir this case their intensity sometimes increases, and Tashkent becomes local area relative to the increased sotryasaemosti. So it is bygone during the Chatkal'skom earthquake of 1946, although its epicenter was located in 250 k, from Tashkent.

Is characteristic also passage through these regions of the shch-'-scale-number izoseysty Uratyubinskogo (1897), Pskemskogo (1937), Namanganskogo (1942), Brichmullinskogo (1959) and Kosh tepinskogo (1965) earthquakes. The epicenters of the first three

earthquakes (7-8 balls) were located far from Tashkent, last/latter two (6-7 balls) it is nearer and to Tashkent. Independent of this and the geological conditions in Tashkent and its neighborhoods earthquakes oshushchalis' almost with identical intensity.

Large material about the frequency in Tashkent of the jolts of different intensity, caused both by close and moved away earthquakes, is assembled during performing work on city planning of city during the years 1964-1965.

On the basis of the obtained material, is comprised the "catalog of the earthquakes, which were being perceived in Tashkent in 100 summers (1886-1965)" (Fig. 194).

SPATIAL DISTRIBUTION OF EARTHQUAKES.

On the basis of the "catalogs of the earthquakes" of region, is comprised the map/chart of epicenters (Fig. 195) on which are placed all the recorded here earthquakes with K = 7 and above.

Their large part pertains to the years 1960-1966, i.e., the operating time of US3. Therefore the coordinate of the overwhelming majority of the epicenters of the earthquakes of opedeleny with the aid of hodograph for a Pritashkentskogo region with error 3-7 km. In entire predydushiy period of the activity of stationary stations, is recorded a comparatively small quantity of earthquakes.

Within the limits of the described territory it is possible to isolate several epicentral zones in which in the extent/elongation of the latter one hundred of summers occurred the strongest earthquakes of the region: Tashkent, Brichmullinskuyu and Koshtepinskuyu.

The Brichmullinskaya zone is arrange/located near the south-west subsidences of the spine/ridges Pskemskogo and to Karzhantau (Fig. 195). Here on 24 October, 1959, occurred the "-scale-number earthquake, which was being perceived in Tashkent (at a distance of approximately 100 km) with the force of 5 balls. Coordinates of seismic center 41°38' north latitude, 70°03' eastern longitude, h = 15 km; K = 14. According to the information, collected V. K. Iodko (Is Butovskaya, etc., 1964), this earthquake was revealed powerful vertical by udaromi it was accompanied by the hum, similar to explosion. Several European type buildings in settlement is bygone destroyed.

The epicenter of Brichmullinskogo earthquake was arrange/located near the intersection of two powerful tectonic disturbances of the paleozoic basement: Ugamskogo and Tashkent-pskemskogo fractures. These fractures are given on the tectonic map/chart of uzbek SSR (Gar'kovets, 1967). Earthquake can be explained by shift one of these fractures.

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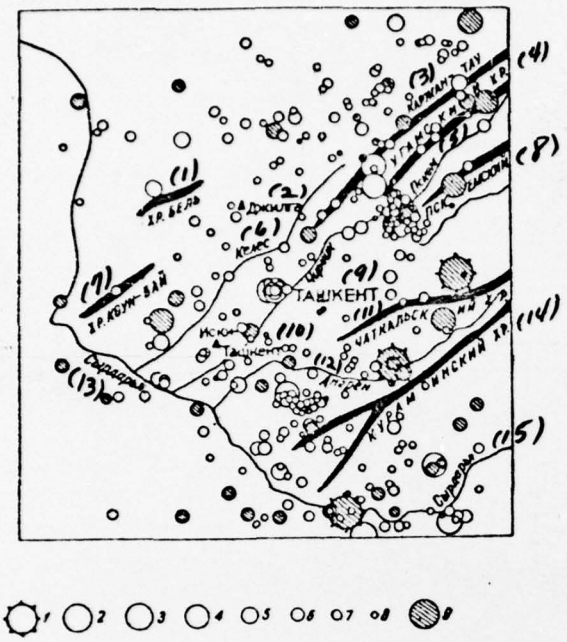

Fig. 195. Map/chart of the epicenters of the earthquakes of Pritashkentskogo region. Classification on the energy class: 1 - K = 15; 2 - K = 14; 3 - K = 13; 4 - K = 12; 5 - K = 11; 6 - K = 10; 7 - K = 9; 8 - K = 8; 9 - the epicenters of earthquakes 1868-1959.

Key: (1). khr, Bel'. (2). illegible. (3). Karzhan - tlu. (4). Ugams km and khr. (5). Eskem. (6). keles. (7). khr. to koui-bam. (8). Actions. (9). Tashkent. (10). Iashkent. (11). chatkal'sk to them khr. (12). Aogren. (13). illegible. (14). kuraminskiy khr. (15). Syrdar'ya.

During the study of the mechanism of the origin/hearth of Brichmullinskogo earthquake and its iterative impulses, it is revealed, which one of the possible discontinuity surfaces in origin/hearth has a strike/course, close to meridional (the same as Ugamskiy fracture), the strike/course of another surface is close to latitudinal (it is analogous with the strike/course of Tashkent-pskemskogo fracture).

Brichmullinskoye earthquake was accompanied by a large quantity of iterative impulses (about 100), the most powerful of which had K = 12 (on 25 October 1959). For 30 repeated tolchikov it was possible to determine the coordinates of origin/hearths. Their epicenters had arranged on the arc of the southwest periphery of Pskemskogo spine/ridge, as if framing it (Zakharov, 1961).

In 1965 20 km northwestern than the Brichmully - on the northern slopes of spine/ridge to Karzhantau - during July one after another occurred two earthquake at K = 12 whose epicenters were timed to the northern continuation of Kenkol'skogo fracture. The dynamic parameters of seismic centers are very close to those which were found earlier for a Brichmullinskogo origin/hearth (Zakharov, 1966).

35-40 Km south-east than the Brichmully near ps. Alabuk is arrange/located the epicenter of the earthquake on 25 October, 1920, with the force of 7-8 balls, K = 15. Its coordirate 41.4° north latitude, 70.4° eastern longitude, are determined with very low accuracy. Therefore it is possible that this earthquake oncsitsya to

Brichmullinskoy epicentral zone.

The Koshtepinskaya zone is arranged/located in 40 k, to the south from Tashkent. Here on 17 March, 1965, occurred "-scale-number earthquake at K = 13, perceived in Tashkent at the force of 5 balls.

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Coordinates of the origin/hearth: 40°50' north latitude, 69°20' eastern longitude, H = 20-25 km. After 17 March is recorded a large quantity of iterative impulses, energy class of which did not exceed 10. The zone of the epicenters of iterative impulses is elongated in the west-north-western direction, close to latitudinal. The same strike/course they have both possible discontinuity surfaces in the seismic center on 17 March. As a result it is possible to assume that the reason for the emergence of earthquakes is the shift on the fracture of west-north-western strike/course, buried here under the powerful layer of unconsolidated deposits.

It is eastern than the Koshtepinskoy epicentral zone - in valley r. The Angren - is arrange/located the epicenter of the earthquake on 4 April, 1868 which was perceived in Tashkent by the force of 7-8 balls. The coordinates of epicenter are 41.1° north latitudes, of 70.0° eastern longitude, K = 15. To indicate that here is located the epicentral zone of powerful earthquakes, obviously, cannot, as the coordinates of the epicenter on 4 April, 1868, are found conditionally

acccrding tc makrcseysmicheskim data. In later pericd are here reccrded the earthquakes with K = 11 and belcw.

The weak earthquakes cf regicn are rcted bcth in the zcnes of the pcwerful earthquakes described abcve and cutside them (Fig. 195). In eastern - the mountain part cf the regicr their epicenters frame Kuramirskiy spine/ridge and the south-west subsidences of spine/ridges Chatkal'skcgc, Pskemskcgc, Ugamskcgc and tc Karzhantau. So, cn the scutheasterly slopes of Kuraminskcgc spine/ridge were observed the fcllcwirg earthquakes: cne with K = 12 (1961), four with L = 1C and mcre than ten from K = 8-9. On the ncrthwesterr slopes of this spine/ridge in valley r. Angren near the epicenters of powerful earthquakes 1868, 1959, 1965 cccurred earthquake (1934) at K = 12 and mcre than ten earthquakes at K = 8-1C.

From the northern slcpe cf Chatkal'skcgc spine/ridge, the chain/retwork cf the epicenters cf earthquakes with K = 8-9 stretches itself tc north to Brichmullinskcy epicentral zcre. In valley r Pskem between Pskemskim and Ugamskim spine/ridges is arrange/located the epicenter of earthquake with K = 12 (1934), but below along the current of river is arrarge/lccated the epicentral zcne of Brichmullinskcgc earthquake (1959). The northern slopes of Ugamskcgc spine/ridge include the epicenters cf earthquakes with K = 12 (1947), K = 11 (1930) and several earthquakes with K = 8-1C. Part cf the spine/ridge tc Karzhantau, that is arrarge/lccated in regior, is framed by the epicenters cf earthquakes r by all its

extent/elongation. In their number, besides two earthquakes mentioned above with K = 12, enter the earthquakes with K = 11 (1947 and 1948) and whole series of earthquakes with K = 8-10.

In the western, plains part of the region, the epicenters of earthquakes form several intersecting zones of northeastern and northwestern strike/courses, by extent 100-120 km. One of such zones stretches itself from northeast to south west from the spurs of the Chatkal'skikh spine/ridges between the rivers of Keles and Chirchik to Tashkent and consists in essence of the epicenters of weak earthquakes with K = 8-9; among them there are only two epicenter of earthquakes with K = 10 and one with K = 11 (1947).

More south-west than Tashkent the described zone is somewhat displaced to north, it continues to r. Syrdar'i, including, besides the epicenters of weak earthquakes (K = 8-10), two more powerful - K = 11 (1933) and K = 12 (1929). It is northwestern on pravoberezh'i r. Keles is arrange/located one additional zone of the epicenters of predominantly weak earthquakes (K = 8-9).

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It stretches itself from the mountain of Dzhesaul on northeast through the Dzhilgu on the right shore of the valley of Sary-Dzhilga to south-west to the spine/ridge of Kounkay.

30-40 Km western than Tashkent both described zones of epicenters intersect by the orthogonal to them zones of northwestern strike/course. One of these zones, nearest to Tashkent, stretches itself from northwest from Changel'dy to the ohe-east to valley r. Argien consists of epicenters in essence of weak earthquakes (K = 8-9). two more powerful earthquakes with K = 10 (27. Oct. 1972) and K = 11 (4. Oct. 1956) they were perceived in Tashkent with the force of 3-4 balls.

Another zone of epicenters, oriented in parallel described, is arrange/located 20-30 km more south-west and passes along the right shore r. Syrdar'i from action-Tashkent on northwest through the Eskent to Kosh-Tepe - on southeast. To this zone of weak (K = 8-9) earthquakes, is timed the perceptible earthquake 10.X 1961 with K = 11.

The zone of weak earthquakes (K = 8-9) stretches itself on river-bed r of Syrdar'i.

According to data of the geological structure of region) r N> Ibragimov, D. Kh. Yakubov) it is possible to assume that the northwestern strike/course of the zones of the epicenters of the western part of the region only seeming. It is possible that the seismic centers can be timed to the crest parts of the contemporary uplift/rises, which stretch themselves in accordance with the common/general/total plan/layout for Alpine tectonics with northeast

tc scuth west.

The depths of origin/hearths are determined for the earthquakes of region, in essence recorded by the grid/retwork of highly sensitive statiors (from 1960). Furthermore, with the aid of the hodograph of Pritashkentskogo regiom are found the depths of origin/hearths for some earthquakes for which is determined the depth, it composes 250. The origin/hearths of 194 earthquakes will lie or depth 0-5 km, 48-10-15 km, 10-20-30 km.

The weighted mean values of depths H_{cp}, calculated for the earthquakes of the different energy classes K, show the tendency of an increase in the depth of origin/hearth with an increase in the energy of earthquake. So, for origin/hearths with $K=8 - H_{cp} = 5$ км; $K=9 - H_{cp} =$ 6—7 км; $K=10 - H_{cp} = 8$ км; $K=11 - H_{cp} = 10$ km and for $K=12 - H_{cp} = 15-20$ km. The obtained average values of depths for different K seem convincing, since for weak earthquakes (K = 8-10) the weight of determinations H_{cp} is sufficiently great, and for powerful earthquakes (K = 11) determinations themselves are produced much more thoroughly.

PARAMETERS OF SEISMIC MODE/CONDITIONS.

Frequency of earthquakes. In Pritashkertskom region according to the map/chart of the epicenters of earthquakes (see Fig. 195) and their energy characteristics, are found three most important parameters of

the seismic mcde/conditions cf regicn - the slcpe/inclinaticn of the curve/graph cf the frequency cf earthquakes, seismic activity and the value cf the maximum possible earthquake. Durirg the descriptien cf the seismicity of the territcry cf republic, is examined the law cf the distributicn of earthquakes accordirg tc seismic energy and is shcwn the curve/graph of the frequency cf the earthquakes of eastern uzbekistan (see Fig. 188). In Pritashkentskcm regicn, because of expeditionary cbservaticns, appeared the pcssibility to increase the range cf the energy klasscvzemletryaseniy, examire/considered during the studies of seismic mcde/conditicns.

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